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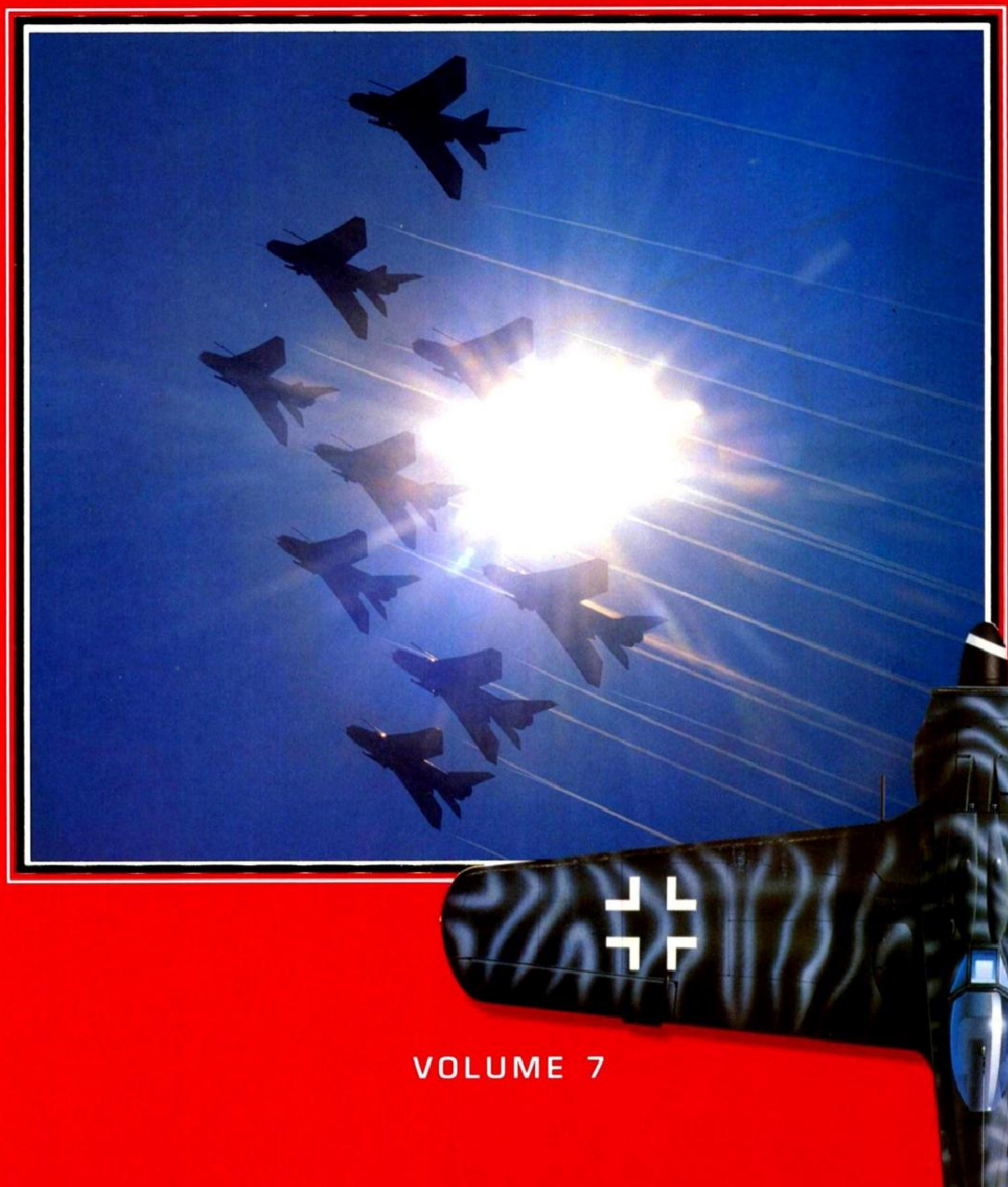

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CONTENTS

Volume 7

Eastern Front Schlachtflieger

The history of the Luftwaffe's ground-attack units and their operations on the Eastern Front **4**

John Weal

McDonnell XF-85

A detailed look at McDonnell's remarkable parasite fighter **26**

Robert F. Dorr

English Electric Lightning

A true British classic, the Lightning was the only supersonic fighter of all-British origin, and is one of the most fondly remembered RAF aircraft of all time. This feature provides a complete review of the type's development, service and technology **36**

Jon Lake

509th Bomb Group

Famous today as the operators of the Northrop Grumman B-2 'Stealth Bomber', the 509th was formed to drop the atomic bombs on Japan. Here the story of their historic mission is told **102**

Warren Thompson

Mariner, Mars and Marlin Variant Briefing

Martin's big 'boats served the US Navy well throughout World War II and into the Cold War era. The variants of the PBM Mariner, JRM Mars and P5M are analysed in detail **114**

Robert F. Dorr

Sukhoi T-4

Unknown in the West until the prototype appeared in a museum, the T-4 was a remarkable Mach 3 bomber, the Soviet Union's reply to the XB-70 Valkyrie **134**

Yefim Gordon

Israel 1950-1959

During the 1950s the IDF/AF grew from a small air arm equipped with World War II-vintage aircraft to a powerful jet force. This *Decade of Air Power* article describes the developments and actions of the growing force **142**

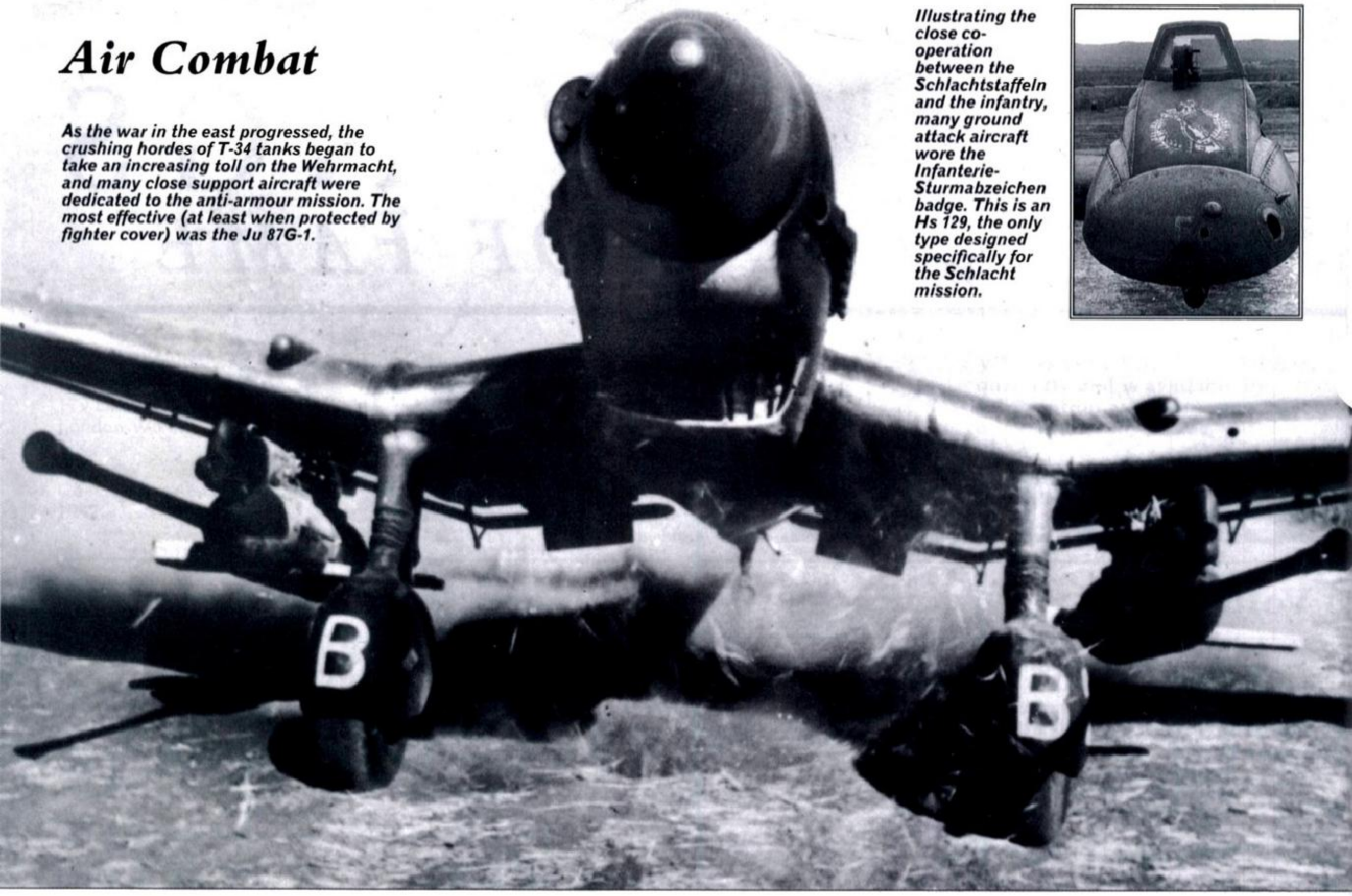
Shlomo Aloni

Index **158**

Air Combat

As the war in the east progressed, the crushing hordes of T-34 tanks began to take an increasing toll on the Wehrmacht, and many close support aircraft were dedicated to the anti-armour mission. The most effective (at least when protected by fighter cover) was the Ju 87G-1.

Illustrating the close co-operation between the Schlachtstaffeln and the infantry, many ground attack aircraft wore the Infanterie-Sturmabzeichen badge. This is an Hs 129, the only type designed specifically for the Schlacht mission.



Eastern Front Schlachtflieger

From humble beginnings the Luftwaffe's Schlacht (ground attack) units grew into a potent force which wrought havoc on the Soviet armies. Ultimately, their efforts only delayed the inevitable defeat.

The very first Wehrmacht communiqué of World War II, issued by the German Armed Forces High Command at the close of the first day's hostilities, contained at least one palpable untruth. Presumably intended to allay anxieties on the home front, while at the same time sounding a warning to a wider foreign audience, the paragraph detailing the Luftwaffe's participation in the first 24 hours of the campaign against the Poles read, in part, "In addition, several Schlachtgeschwader provided effective support for the advancing army."

In reality, upon the outbreak of war the Luftwaffe's entire Schlacht, or ground attack, arm consisted of just one Gruppe – 39 serviceable aircraft, to be precise – of obsolescent biplanes!

The Henschel Hs 123, which made its public debut at Berlin-Johannisthal piloted by Ernst Udet on 8 May 1935, was the result of an RLM specification issued 15 months earlier calling for a 'Sofortlösung', an 'immediate solution' or interim machine, to bridge the yawning gap before the advent of the Luftwaffe's definitive dive-bomber (the Junkers Ju 87). Despite Udet's bravura performance at the controls of the first prototype, the Hs 123, which had been designed to possess a dual-role capability as both a single-seat fighter and a dive bomber, was to fall heavily between these two stools.

In the period from September 1936 to the spring of 1937, six Hs 123A production aircraft were nonetheless despatched to the Condor Legion in Spain. The first three were formed into a so-called Stukakette under the command of Leutnant Heinrich 'Rubio' Brücker. The Legion's chief of staff, Oberstleutnant Freiherr Wolfram von Richthofen (who, despite his later eminence as the Luftwaffe's foremost exponent of Stuka operations, was no great advocate of the dive-bomber in its early days), was more interested in utilising the Hs 123 in the close-support role. And in this – despite the loss of four of the six aircraft – it proved remarkably successful. Henschel's pugnacious-looking sesquiplane had found its true niche in the history of aerial warfare.

The Hs 123's performance in Spain at first evoked little interest in the Homeland, however, where production had already been cancelled in favour of the Junkers Ju 87. Despite this lack of regard, employment was found for the Hs 123 in the weeks leading up to the Munich Crisis of September 1938. To bolster those Luftwaffe units gathering along the disputed borders of the Sudetenland, a temporary Fliegergeschwader 100 was activated as an emergency ground-attack command. Three of its five component Gruppen were equipped with Hs 123s (the other two flying the Heinkel He 45). The signing of the Munich Agreement and the subsequent easing of international tension led to the rapid dissolution of Fliegergeschwader 100 and the incorporation of its subordinate Gruppen into other established Geschwader; three became Stukagruppen and the fourth a Kampfgruppe.

The fifth, Major Rentsch's Fliegergruppe 20 – paradoxically one of the two He 45-equipped Gruppen – was selected as the sole unit within the Luftwaffe to be charged with keeping alive

In the opening months of Barbarossa, Luftwaffe aircraft flew many low-level strafing missions against the retreating Russians. Here a horse-drawn convoy scatters during a low-level attack.

Above: Without doubt the Fw 190 was the finest ground attack aircraft on the Eastern Front. In addition to the dedicated Fw 190Fs, Jabo Fw 190As (like this A-5/U3) were widely used in attacks on Soviet forces by both Schlacht and fighter units.

Right: In the early part of the Schlacht campaign, the Hs 123 demonstrated its forte in the true close support role, as previously displayed over Poland and the Low Countries.

(just!) the flickering flame of close support.

Reinforced by a number of pilots (including the Kommandeur and two of the three Staffelkapitäne) from Fliegergruppe 40 – the other He 45 unit – and transferring from Breslau back up to Tutow in Brandenburg on 1 November 1938, Fliegergruppe 20 exchanged its Heinkels for Hs 123s and joined the ranks of the Lehrgeschwader. The Luftwaffe's two Lehrgeschwadern were instructional test units composed of entirely disparate Gruppen, each tasked with evaluating a particular type of aircraft with a view to its ultimate operational use and deployment. LG 2's first Gruppe, for example, was a single-engined fighter unit, and its third a reconnaissance formation. Charged with the development of close-support tactics, Major Rentsch's Gruppe was slotted between the two under its new guise as II.(Schl)/LG 2.

Preparation for war

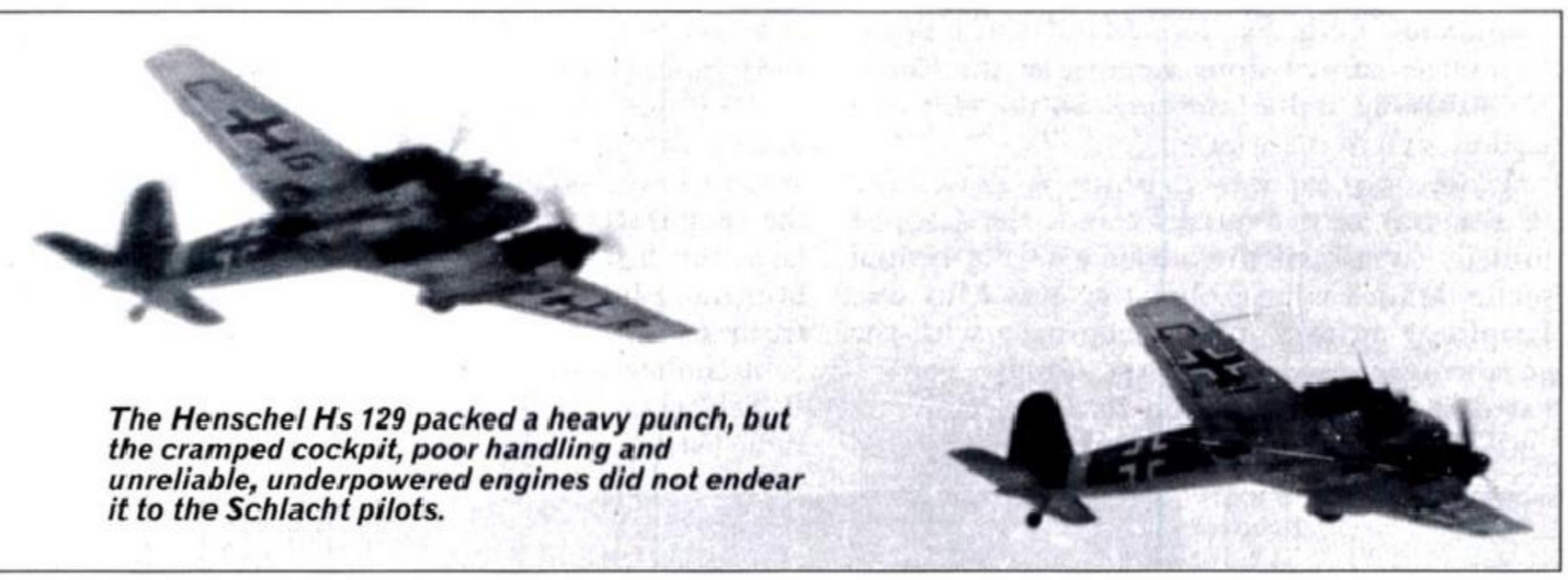
Ten months later the Gruppe's 39 Hs 123s, commanded now by Major Werner Spielvogel, moved to Altsiedel in Silesia and prepared for war. Together with three Stukagruppen they formed the strike arm of Generalmajor Wolfram Freiherr von Richthofen's Fliegerführer z.b.V., a special-duties command established to support the German army's drive on Warsaw. Von Richthofen obviously remembered the Hs 123 from his days in Spain and was all too aware of the type's major shortcoming: its notorious lack of range.

"By the time Spielvogel and his Krähen (crows) finally reach the front line from Altsiedel," he complained, "they will have used up half their fuel." Orders were immediately cut to move II.(Schl)/LG 2 to a forward airstrip at Alt-Rosenberg very near the Polish border. For the next two weeks they flew almost without pause, sometimes as many as 10 sorties a day, wreaking havoc on enemy troops and clearing the path for the Panzers' advance on the Polish capital. The Hs 123's unexpected success in Poland – its ease of maintenance in the field, its ability to absorb ground-fire (sometimes even direct anti-aircraft hits) and yet continue flying – gave it a whole new lease of life. From an aircraft scheduled for retirement long before the war had even begun, the Hs 123 had suddenly become a valuable addition to the Luftwaffe's armoury.

The one major loss suffered by the Gruppe in Poland was that of their Kommandeur, brought down during a reconnaissance flight in a Fieseler Storch on 9 September. His place was taken by the Staffelkapitän of 4.(Schl)/LG 2, Hauptmann Otto Weiss. Weiss, like Spielvogel, had been another transferee from the original Fliegergruppe 40, and it was he who led the Gruppe in the May 1940 Blitzkrieg in the West, where again it proved its worth in close support of the Wehrmacht's ground forces from the Dutch border to the French Atlantic coast.

The end of the campaign in France threw up an insuperable hurdle to the Hs 123's hitherto unbroken run of success: the English Channel. While the majority of the Luftwaffe's combat units took the fight to England's shores, II.(Schl)/LG 2 flew its short-legged Henschels back to Brunswick-Waggum in Germany, where they re-equipped with the Messerschmitt Bf 109E.

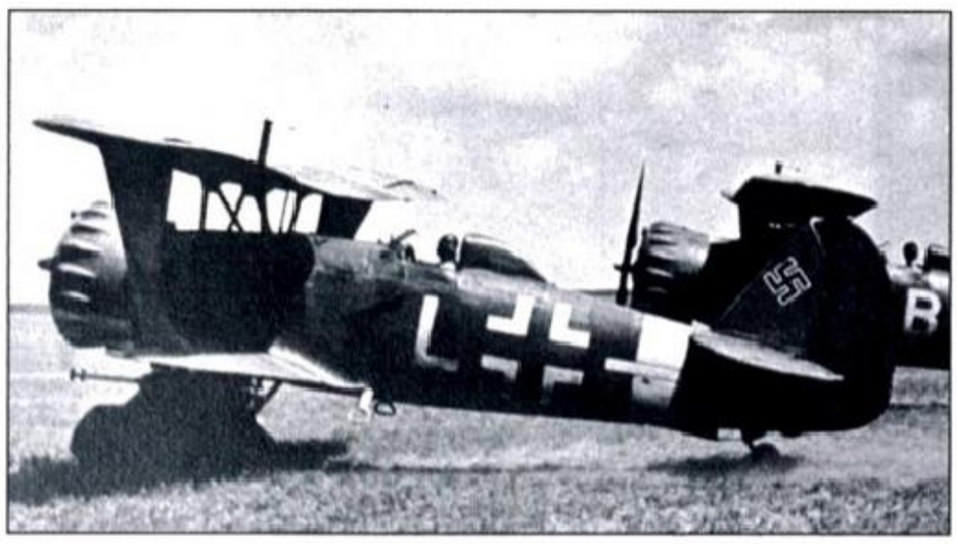
After fighter-bombing training at Böblingen the unit returned to the Channel coast, two-Staffeln strong, in mid-August. They did not rejoin von Richthofen's VIII.Fliegerkorps (whose Ju 87 Stukagruppen were soon to be withdrawn from the Battle), but went instead to II.Fliegerkorps. Stationed in the Pas de Calais alongside that command's Erprobungsgruppe 210, a mixed-formation trials unit of Bf 109 and Bf 110 fighter-bombers, II.(Schl)/LG 2 spent the latter half of the Battle of Britain flying Jabo



The Henschel Hs 129 packed a heavy punch, but the cramped cockpit, poor handling and unreliable, underpowered engines did not endear it to the Schlacht pilots.

Left: Seen in August 1941 this group contains four of the first five Knight's Cross recipients on the Eastern Front. From left to right they are Major Otto Weiss (Gruppenkommandeur of II.(Schl)/LG 2), Oberleutnant Georg Dörffel (Staffelkapitän 5.(Schl)/LG 2), Generaloberst Alfred Keller (AOC Luftflotte 1), Oberleutnant Werner Dörnbrack (Staffelkapitän 6.(Schl)/LG 2) and Oberleutnant Bruno Meyer (Staffelkapitän 10.(Schl)/LG 2). The fifth was Oberleutnant Alfred Druschel, the 4.Staffel leader.

Right: A Bf 109E from II./SchlG 1 takes off on a summer mission. The Mickey Mouse badge was used by the whole Gruppe, having been inherited from 4.(Schl)/LG 2.



Above: Seen in 1942, these II./SchlG 1 Hs 123s are armed with bombs with Dinortstäbe percussion rods. These were invented by Major Oskar Dinort, Kommodore of StG 2, and were used for anti-personnel attacks.

Below: Steering the Hs 123 could be tricky because of the lack of forward visibility, so ground crew often sat on the wing to direct the pilot to the runway.

Carrying four SC 50s under their wings, a group of Henschel Hs 123s awaits the next mission at a forward base during the summer 1941 offensive. The Hs 123 had a short range, but its rough-field capability allowed it to advance with the troops.

sorties over the southern counties. Some measure of its success in this new role may be gauged from the fact that Reichsmarschall Göring, increasingly irritated by his bombers' failure to destroy the RAF, subsequently ordered that a third of his entire Channel-based Jagdgruppen be converted to fighter-bombers.

In the spring of 1941 Hitler turned his attention to the Balkans. A major part of the Luftwaffe strength despatched southeastwards for the forthcoming offensive was provided by VIII.Fliegerkorps. Its Ju 87s resumed front-line combat under the protection of the Korps' own single-seat fighter component (which now included the Bf 109s of I.(J)/LG 2).

II.(Schl)/LG 2 also returned to the von Richthofen fold for the invasions of Yugoslavia and Greece, with its two Staffeln of Bf 109s being based at Sofia-Vrazdebna in Bulgaria. It was the prospect of imminent action against enemy troops in the field which brought about the resurrection of the Luftwaffe's one true close-support machine. Thirty-two Hs 123s, which had been 'retired' nearly a year earlier, were used to equip a new strengthened Staffel, 10.(Schl)/LG 2, which was deployed to Krainici close to Bulgaria's frontier with Yugoslavia. Once again, the venerable biplanes, each resplendent in its new theatre markings of brilliant yellow cowling and rudder, performed their unique role to perfection. An even greater challenge lay ahead.

Operation Barbarossa

The invasion of the Soviet Union on 22 June 1941 saw all three branches of the Luftwaffe's current tactical arsenal represented along the length of the new 1600-km (995-mile) front. Most numerous were the dive-bombers, seven Stukagruppen in all. Next came the Bf 110 fighter-bombers, expanded since the days of the Channel front Erprobungsgruppe into SKG 210, a dedicated Schnellkampfgeschwader (fast bomber group). Lastly, and after nearly two years of war still the only Schlachtgruppe in existence, there was II.(Schl)/LG 2.

Flying the same mix of machines as in the recent Balkan campaign – namely three Staffeln of Bf 109Es (38 aircraft, all but one serviceable) plus a fourth Staffel of 22 Hs 123s (17 serviceable) – II.(Schl)/LG 2 embarked upon the invasion of Russia. It was still subordinated to VIII.Fliegerkorps and was once again under the command of the by then-Major Otto Weiss (recently returned from a course at the Berlin Air Academy and a brief spell on the staff of a Jagddivision in the west).

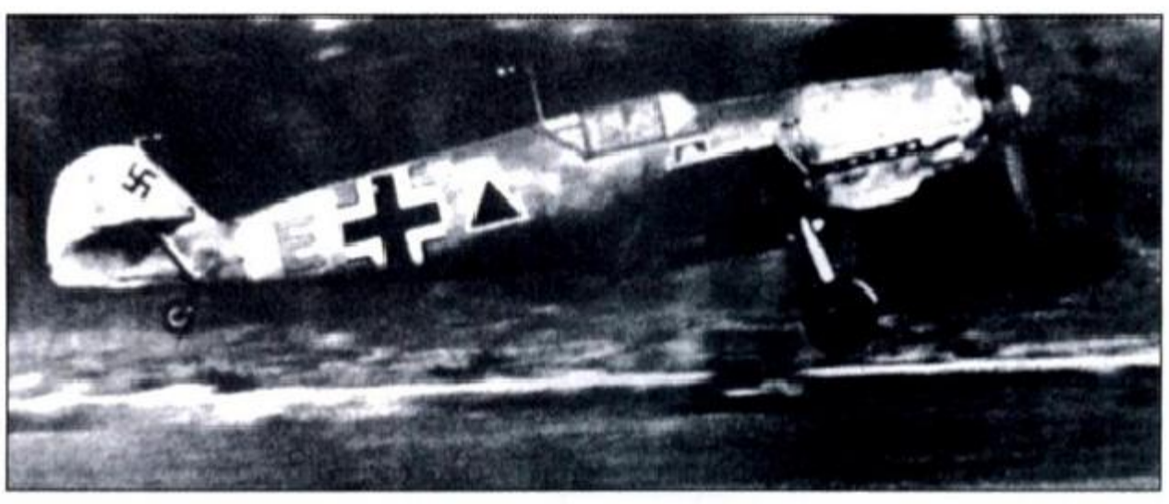
From its jumping-off point at Praschnitz (Przasnysz) in occupied Poland, the Gruppe initially supported the advance of the central sector armies whose objective was Moscow. Leapfrogging forward to keep pace with the advancing ground troops, the Gruppe participated in the great cauldron battles of Bialystok and Minsk and the Panzers' subsequent drive on Smolensk. The rigours of these first weeks of hectic campaigning soon began to reveal the Bf 109s' inherent weaknesses. Constant powerplant and undercarriage problems meant 4.-6.Staffeln could seldom muster more than a dozen serviceable machines between them.

In contrast, the Hs 123s of 10.(Schl)/LG 2 seemed able to thrive however primitive the conditions. There was already a tried-and-tested method within the Staffel for selecting new airstrips: they simply looked for a pasture or any suitable piece of ground large enough to accommodate the Henschels' 200-m take-off run, and drove a truck across it at 50 km/h. If the occupants were not jolted around too much, they had found their next landing ground.

Early in August VIII.Fliegerkorps was transferred to the northern sector of the front to support the attack on Novgorod and the fighting around Lake Ilmen. It was at this juncture that II.(Schl)/LG 2 received its first Ritterkreuze (Knight's Crosses) of the Russian campaign (four having already been awarded during and after the Blitzkrieg in France), when all four Staffelkapitäne were simultaneously decorated on 21 August for their performance and leadership in the recent actions along the road to Smolensk.

By the end of September, after briefly participating in operations against Leningrad and around Lake Ladoga, the Gruppe was back on the central sector (thereby completing, incidentally, the first of the increasingly frequent and ever more hectic transfers from one area of the front to another which would bedevil the Schlachtflieger in the months and years ahead). II.(Schl)/LG 2 became heavily embroiled in the twin battles for Bryansk and Vyazma and the

Bf 109Es partnered Hs 123s in the early part of the Schlacht campaign, this II./SchlG 1 example carrying four SC 50 bombs on the fuselage rack. At the time (summer 1942), the Gruppe was fighting across the Ukraine.



The Bf 109E did not carry any more bombs (four SC 50s) than the Hs 123, but was far more able to look after itself as Soviet fighter opposition grew. Many of the Schlacht pilots compiled respectable aerial tallies.

Configuration
The Hs 123 was a single-bay sesquiplane with an N-strut arrangement mounting the upper centre-section and a single canted interplane strut on either side. The single-spar lower wings carried simple flaps.

Weapon load
Standard armament of the Hs 123A consisted of two 7.9-mm MG 17 machine-guns in the upper nose decking, useful only for strafing and aimed with a simple ring-and-bead sight. Underwing racks could mount up to four SC 50 50-kg (110-lb) bombs, two 20-mm cannon pods or two containers each with 94 SC 2 anti-personnel bombs. This aircraft carries four SC 50s, each fitted with a Dinortstäb fuse-extender for above-ground detonation and tail screamers ('trumpets of Jericho') to increase the psychological terror of the attack.

Belly tank
The Hs 123 had centreline shackles for a non-jettisonable belly tank, but this was only used for ferry flights as it was too vulnerable for operational use.

Hs 123 in the east
II.(Schl)/LG 2 transferred from the Balkans for Operation Barbarossa, being withdrawn in January 1942 to form the nucleus of I./SchlG 1. Hs 123s later equipped II./SchlG 1, and I. and II./Schl G 2, using aircraft hauled out of second-line training units. In January 1943 consideration was given to reinstating the Hs 123 in production. The last front-line survivors were concentrated in II./SG 2, retiring in mid-1944.

Henschel Hs 123A 5.(Schl)/LG 2 Moscow front Central Sector Winter 1941/42

Originally designed as a dual-role fighter/dive-bomber, the Hs 123 found its true niche as a close support aircraft. It was particularly effective against the horse-drawn forces prevalent in Europe in the early years, the psychological effect of the noise of its engine as it screamed across columns at very low level being as great as the destructive effect of its weapons. It survived in the ranks of the Schlacht-flieger until mid-1944.

Unit markings
This aircraft wears the white-edged black triangle marking of the ground attack units. It was certainly worn by the Hs 123s of the temporary Fliegergruppen established at the time of the Sudeten crisis in September 1938, and is believed to have dated back to World War I. In addition to the infantry assault badge (partially obscured by the interplane strut), the aircraft carries the badge of 5.Staffel, which consisted of the Berlin bear chopping up Chamberlain's umbrella. By late 1941 this was decidedly anachronistic, and was dropped soon after.

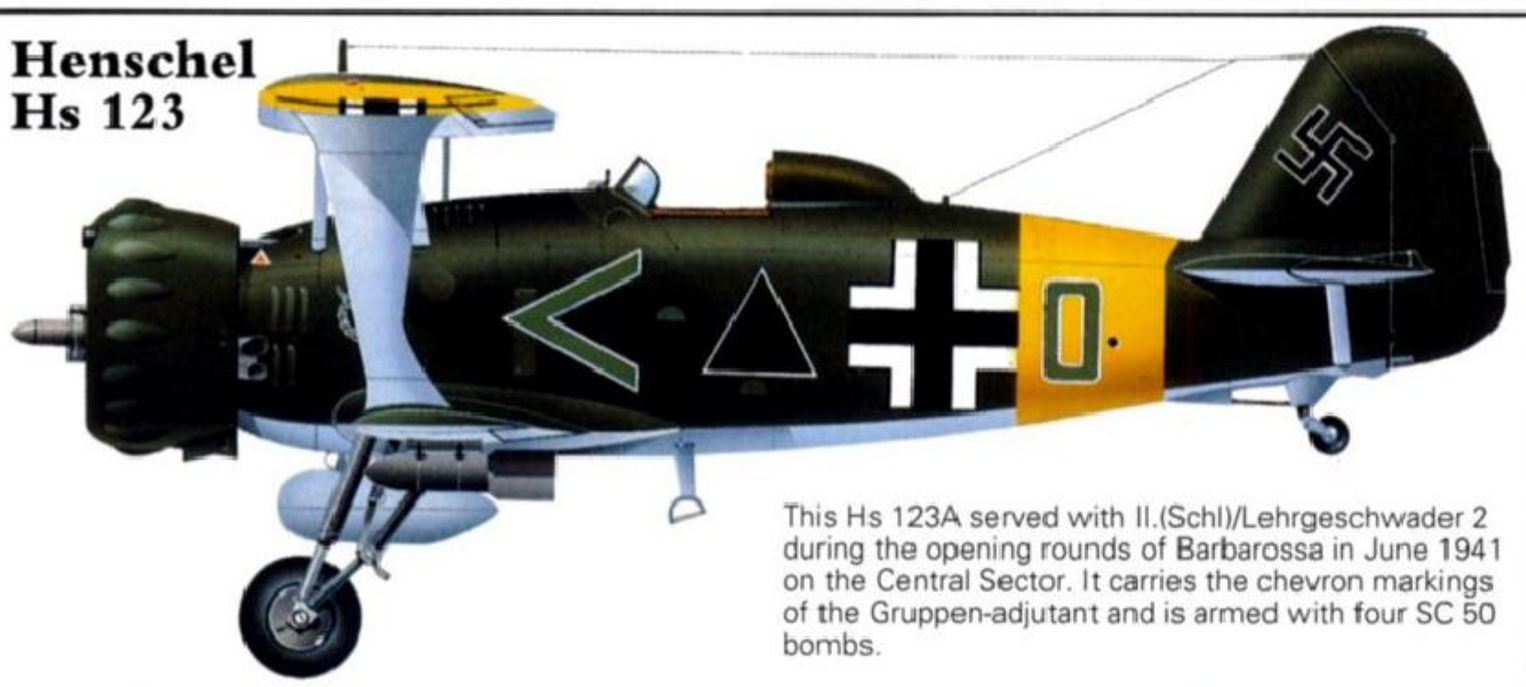
Hs 123 prototypes
The V1 first prototype flew in early 1935, fitted with a smooth long-chord cowling. The V2 and V3 both had shorter cowlings with bulges over the cylinder heads. The V1 and V2 had three-bladed propellers, replaced in the V3 by a two-bladed variable-pitch airscrew. The V3 also had armament fitted. The V4 had a strengthened centre-section following the mid-air break-up of two of the earlier machines.

Camouflage and national insignia
For winter operations aircraft were regularly painted with a white soluble distemper over the permanent splinter camouflage, leaving just the unit and national insignia. Owing to the sesquiplane configuration of the Hs 123, the lower national insignia and yellow theatre identification band were applied to the undersides of the upper wing, as that would be easier to see from the ground.

Powerplant
All front-line Hs 123As were powered by the very reliable BMW 132Dc nine-cylinder radial engine with direct fuel injection. This developed 880 hp (657 kW) for take-off and 870 hp (649 kW) at 2500 m (8,200 ft). The four prototypes were powered by the 650-hp (485-kW) BMW 132A-3, while the V5, prototype for the abandoned Hs 123B series, had a 960-hp (716-kW) BMW 132K driving a three-bladed variable-pitch propeller.

Cockpit
The simple open cockpit had a padded coaming and a ring-type control column. The armoured headrest was inherited from the V6 prototype for the Hs 123C, which also featured an enclosed canopy.

Undercarriage
On the Eastern Front the sturdy undercarriage was often left unfaired to avoid a build-up of mud and slush. The Hs 123 was renowned for its rough-field capability, which allowed it to operate in conditions when other types were grounded.



This Hs 123A served with II.(Schl)/Lehrgeschwader 2 during the opening rounds of Barbarossa in June 1941 on the Central Sector. It carries the chevron markings of the Gruppen-adjutant and is armed with four SC 50 bombs.

bitter struggle for Kalinin, a key city 100 miles (60 km) northwest of Moscow. It was at the height of the fighting for Kalinin in October that a series of Soviet counter-attacks threatened to overrun the Gruppe's base at Rusha 80 km (50 miles) from the Russian capital. For several days, in worsening weather and rarely flying at an altitude of more than 50 m (165 ft), all four Staffeln were engaged over the area of the breakthrough before they finally succeeded in bringing the enemy's combined armoured and infantry assault to a standstill. (Along with the frequent transfers, the constant danger of a German pilot's own forward airstrip being overrun by a surprise Soviet counter-attack would soon become a fact of daily life for every Eastern Front assault pilot.)

As October gave way to November, the onset of winter (which would see temperatures plummeting to -30°C/-22°F or more) combined with stiffening Russian resistance to bring the Wehrmacht grinding to a halt at the gates of Moscow. As the ground troops dug in, II.(Schl)/LG 2 continued to operate whenever weather conditions permitted. The pilots of 10.Staffel suffered particular hardship in the open cockpits of their Henschels. With the entire tactical air arm in the east so thinly stretched (Stuka strengths, for example, were currently little more than 50 per cent of what they had been on the opening day of Barbarossa), there could be no respite for the Schlachtflieger. When Stalin launched his great winter counter-offensive on the Moscow front in the second week of December, it was only with the help of local Luftwaffe air commanders hanging bombs on anything that could fly – Bf 109 fighters, Henschel Hs 126 and Focke-Wulf Fw 189 reconnaissance machines, even Fieseler Storch communications aircraft – that II.(Schl)/LG 2 managed to survive, let alone hold.

Above left: The cockpit of the Hs 129 was very cramped. Visible on the sliding side glazing are lines denoting the dive angles for attacks.

Left: Hauptmann Rudolf-Heinz Ruffer, Staffelkapitän of 8.(Pz)/SchlG 1, stands in front of his Hs 129B. Ruffer was the first Hs 129 pilot to receive the Knight's Cross.

Right: The tailplane of an Hs 129 makes as good a place as any for these pilots to plan their mission. The aircraft served with either 4.(Pz)/SchlG 1 or 4.(Pz)/SchlG 2.

Expansion

By mid-January 1942 the Soviet push, having achieved its main object of removing the immediate threat to the Russian capital, began to lose some of its momentum.

After seven months' hard campaigning in the east by II.(Schl)/LG 2, the importance of direct close-support aircraft in major land battles had finally been impressed upon the Luftwaffe High Command. That same January the Gruppe was ordered back to Germany for rest, refit and expansion.

There are conflicting reports on exactly how II.(Schl)/LG 2 was reconstituted as Schlachtgeschwader 1, the first dedicated close-support group to be established within the Luftwaffe. Some published sources state that II.(Schl)/LG 2 was simply redesignated as I./SchlG 1 and that a new II./SchlG 1 was formed entirely from scratch. Other, archival, material maintains the opposite: that II.(Schl)/LG 2 became II./SchlG 1 and that I./SchlG 1 was the new formation. Suffice it to say that, just as men and material from both Fliegergruppen 20 and 40 had been combined to create II.(Schl)/LG 2 in the days before the war, so the latter's four Staffeln provided the nuclei for two completely new Gruppen of three Staffeln each: I./SchlG 1 at Werl, east of Dortmund, under the command of Hauptmann Alfred Druschel, long-serving Kapitän of 4.(Schl)/LG 2; and II./SchlG 1 at nearby Lippstadt, headed by newcomer Hauptmann Paul-Friedrich Darjes, an ex-bomber pilot from KG 51. Fittingly, the officer appointed as the first Kommodore of Schlachtgeschwader 1 was Major Otto Weiss, the man who had led II.(Schlacht)/LG 2 throughout most of its operational career.

Although the bulk of the new Geschwader was equipped with the Bf 109E (most of the seemingly indestructible Hs 123s now being concentrated in 7./SchlG 1), Lippstadt also housed the Luftwaffe's close-support training and replacement wing. This unit operated a handful of Henschel's second foray into close-support aircraft production, the twin-engined Hs 129. Heavily armed and armoured, the Hs 129 was a purposeful-looking machine designed to present as small a frontal target as possible. So cramped was the cockpit, in fact, that the instrument panel was not large enough to accommodate all the engine instruments and a number of them later had to be mounted externally on the inner faces of the engine nacelles themselves. With their two 415-hp (310-kW) Argus As 410 air-cooled inline engines, these early Hs 129As were seriously underpowered, as the pilots who flew them at Lippstadt soon discovered. Nonetheless, they did manage some fancy aerobatics, despite the Argus-powered Hs 129s being variously described elsewhere as possessing "only marginal performance" and needing "extreme force" to keep it under control – the control column, for example, was only 20 cm (8 in) long.

French powerplant

Early in 1942, the first of the re-engined Hs 129B-1s, powered by two 700-hp (522-kW) Gnome-Rhône 14M radials, were delivered to the Luftwaffe; 16 examples were used to equip the newly activated 4./SchlG 1. By the end of April 1942 SchlG 1, with the exception of 4.Staffel still working up on its Hs 129s, was deemed combat-ready and transferred to the command of Luftflotte 4 on the southernmost sector of the Russian front. Departing their Westphalian bases, 120 Bf 109Es and 15 Hs 123s staged via Breslau, Cracow, Lemberg (Lvov), Uman and Nikolayev to take up residence at Gramatikovo in the Crimea.

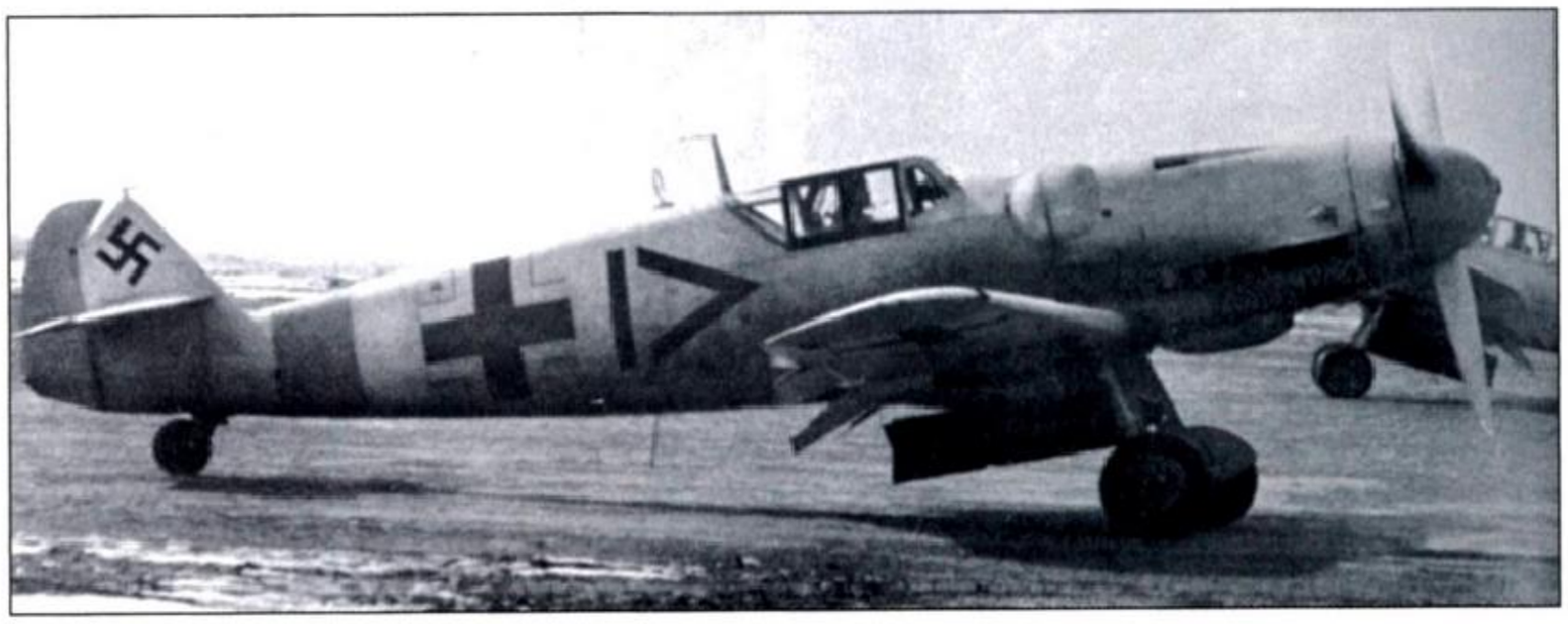
Commencing operations on 7 May, SchlG 1 spent two weeks in the Crimea supporting ground forces in the clearance of the Kerch peninsula. Their first losses were sustained within 48 hours, a sobering experience for those newly-joined young pilots fresh out of training school, and a grim portent of things to come.

On 25 May, the day after the Russians had evacuated Kerch, Oberleutnant Heinz Frank, Staffelkapitän of 3./SchlG 1, was flying a reconnaissance mission in the region of Kharkov when he spotted Soviet tanks south of the town. It was the start of a full-scale counter-offensive launched by the enemy to forestall the Wehrmacht's expected summer offensive in the

Left: An early Bf 109E (note the original canopy framing) is seen during the first winter on the Russian front. It is carrying four SC 50 bombs under the fuselage.

Below: On the Central Sector, the reinforced Stabsstaffel of JG 51 flew from late 1942 as a semi-autonomous Jabo unit, operating a mix of Bf 109Gs (illustrated) and Fw 190s.

Climbing into his Bf 109E-7 at Kharkov in spring 1943 is Major Alfred Druschel, Geschwaderkommodore of SchlG 1. The unit was converting to the Fw 190, but Druschel clung on to his favoured '109.



Ukraine. SchlG 1 was rushed north to Kharkov-Rogan: "We attacked the armoured spearheads which had broken through. Flying one sortie after another from dawn till dusk without break. Living on coffee and sandwiches while our aircraft were refuelled and rearmed. The ground crews performed miracles. But we stopped the Ivans."

By then 4.Staffel, already reduced to just 12 Hs 129s, had also arrived at the front. Unlike its biplane predecessor, Henschel's latest offering was no robust bruiser. Teething troubles abounded and serviceability suffered accordingly. The Gnome-Rhône engines, albeit more powerful, were particularly temperamental: liable to seize without warning, incapable of absorbing any but the most trivial of battle damage and highly sensitive to the all-pervading dust of the southern Russian steppe in mid-summer (not surprisingly, a second Staffel of Hs 129s later despatched to the North African desert fared even more disastrously).

With the enemy's spoiling tactics around Kharkov neutralised, the Wehrmacht was free to launch its own great summer offensive. This was not to be a second attempt to capture Moscow. This time – at the insistence of the Führer himself – the main lines of advance were along the southern flank aimed at the oilfields of the Caucasus and a town on the River Volga called Stalingrad.

Drive to Stalingrad

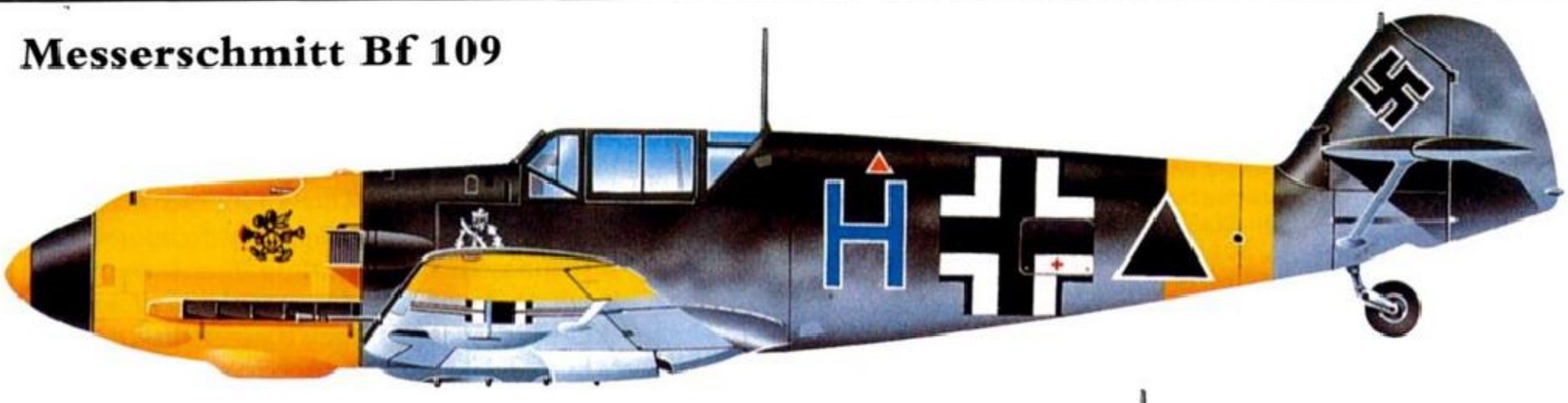
To support this drive SchlG 1 moved from Kharkov-Rogan down to Slavyansk in the Donets Basin. The unit was heavily committed from the outset. While the Hs 123 and 129 Staffeln (their limited numbers permitting) harried the enemy infantry and armour, the Bf 109 pilots found themselves facing increasing numbers of defending Soviet fighters. Some, frustrated fighter pilots at heart, actively sought such confrontations. One such was 8.Staffel's Oberfeldwebel Otto Dommeratzky, a veteran of II.(Schl)/LG 2 since the days of the Polish campaign.

Dommeratzky's wingman, himself only recently out of Jagdschule, describes one of their early sorties together: "Flying with Otto was a revelation. I learned a lot from him. He flew much better than most – with a lot more cunning – always thought his attacks out beforehand. But he paid scant regard to his wingman. It was a case of keep your eyes open and your wits about you. Otherwise you were in trouble. He was a natural. If he spotted enemy fighters he was after them like a shot, jettisoning his bombs and seeking a favourable position for the attack. He always made sure he had the height advantage – he was a true Jäger, it was in his blood. At first I had my work cut out anticipating and following his every manoeuvre. I soon experienced the first kills with Otto – my previous leader had never looked for opponents in the air – kills the like of which I could only dream of in Jagdschule.

"The Kommandeur was not at all happy at Otto's insatiable appetite for dogfighting; that he simply dumped his bombs. Our role, after all, was to attack ground targets and support our own ground forces. Despite all the chief's instructions, Otto never passed up an opportunity. He just couldn't do otherwise.

"One day Otto and I headed north out of Slavyansk on an infantry-support mission. We

Messerschmitt Bf 109



In the winter of 1942 this II./SchlG 1 Bf 109E-7/B was embroiled in the battle for Stalingrad. Note the Infanterie-Sturmabzeichen badge carried by many of the Schlacht aircraft.

This gaudily camouflaged Bf 109E-4B Jabo aircraft was flown by Leutnant Steindl, Geschwader-adjutant of JG 54 'Grünherz', which was in the Leningrad area in spring 1942. In addition to Steindl's personal marking, it carries the II./JG 54 emblem of the Vienna-Aspern coat of arms.

Above: Tanks were the most important target for the Schlacht units, this column of T-34s having been destroyed at Rzhev. Hans-Ulrich Rudel led the tank-killers, with 519 to his credit.

Left: Trains were also prime targets, this railyard having been visited by Ju 87s.

bombed an enemy mortar position as ordered and were on our way back when we bumped into a gaggle of Soviet LaGG-3 fighters – 15 or 20 of them. We were at about 1500 m, but Otto had already waded in. Utter confusion: we were not only in the minority, but this time at a real disadvantage. We had spotted them too late – more correctly, I should say I had not spotted them at all!

"Otto was weaving in and out like a madman. It was all I could do not to lose him, my machine surrounded by nothing but 'Red Stars'. The dogfight had lasted five to six minutes when suddenly Otto's machine took some hits and burst into flames. He baled out but I didn't see what happened after that as I was concentrating on escaping southwards at low level.

"Somehow I made it back to base. I had learned another hard lesson. We'd been taken completely by surprise by the sudden appearance of the LaGGs – eyes open, always keep your eyes open!

"The chief was not exactly overjoyed at my reporting Otto missing. Division was informed. And the army unit we had been supporting. About an hour later they got back to us: Otto had come down unhurt in the lines of a mountain regiment 40 km to the north of us and could we please send someone to pick him up!"

Flying artillery

As the Germans advanced on Stalingrad in the high summer of 1942, Soviet resistance hardened; not just in the air, but on the ground too. Newer Russian tanks – more heavily gunned and armoured than their German counterparts – were leaving the production lines and starting to appear at the front in growing numbers.

It was feared that the German army's own anti-tank units would prove insufficient to deal with this latest threat. Despite their sterling service, SchlG 1's use of bombs to knock out individual tanks was not the most effective of methods, either. Seeking a solution to the problem, the Luftwaffe proposed the creation of specialised anti-tank Staffeln of aircraft equipped with large-calibre cannon. The first operational trials of just such a machine – the Henschel Hs 129 fitted with an additional ventral 30-mm MK 101 cannon – had seemed promising. Several examples had been delivered to 4./SchlG 1 in June and had succeeded in destroying 23 Soviet tanks during the closing stages of the fighting around Kharkov.

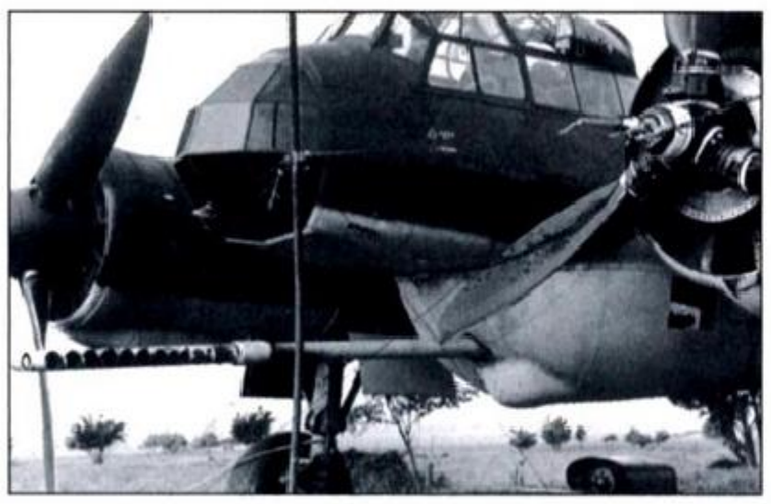
The second operational Hs 129 Staffel to be activated was therefore created specifically for the anti-tank role. Set up at Deblin-Irena under the auspices of the resident Ergänzungsgruppe ZG 1, this so-called Panzerjägerstaffel was scheduled to enter service as of 1 September 1942 attached to JG 51 on the central sector of the Eastern Front.

In the event, yet another of the local 'crises' which were to erupt with increasing frequency in the east caused the new Staffel's training programme to be abruptly terminated. This latest one was a surprise counter-thrust by the Soviets around Vyazma in the central region, intended to alleviate pressure on their southern flank. In mid-August the unit was rushed to Vyazma (its parent Geschwader's area of operations) where the Hs 129s reportedly proved themselves 'formidable can-openers'. It soon became apparent, however, that the 30-mm MK 101 was incapable of penetrating the armour plate of the newer Russian tanks coming into service, and the Staffel increasingly turned instead to the use of 4-kg (8.8-lb) SD 4 hollow-charge bombs.

Plans to attach a similar Panzerjägerstaffel to every Eastern Front single-seat Jagdgeschwader were never implemented, and Oberleutnant Egger's Pz.J.St./JG 51 remained the only one of its kind.

The concept of the 'flying anti-tank gun' was not abandoned. At the end of 1942 Major Otto Weiss – who had relinquished command of SchlG 1 to Major Hubertus Hitschold back in July to head the Inspectorate of Schlacht- and Zerstörerflieger – was ordered to Rechlin-Roggenthin to set up the Versuchskommando für Panzerbekämpfung (Anti-Tank Trials Command). This unit was tasked with testing even larger-calibre cannon on a variety of aircraft: the Hs 129 with the MK 103 (an improved MK 101 with increased muzzle velocity), the 37-mm BK 3.7, 50-mm BK 5 and 75-mm BK 7.5; the Ju 87D fitted with a BK 3.7 under each wing; the Bf 110G with the BK 3.7; and the Ju 88P with the BK 50, 75-mm BK 7.5 and PaK 40.

Nicknamed 'die Dicke Bertha' ('Fat Bertha'), the Ju 88P V1 was a Ju 88A-4 fitted with a 75-mm KWK (Kampfwagen-Kanone) 39 gun in an immense ventral gondola. This trials anti-tank weapon led to a few operational Ju 88P-1s, although they featured a solid nose and the better PaK 40 weapon. They saw some service with Panzerjägerstaffel 92 in early 1944.



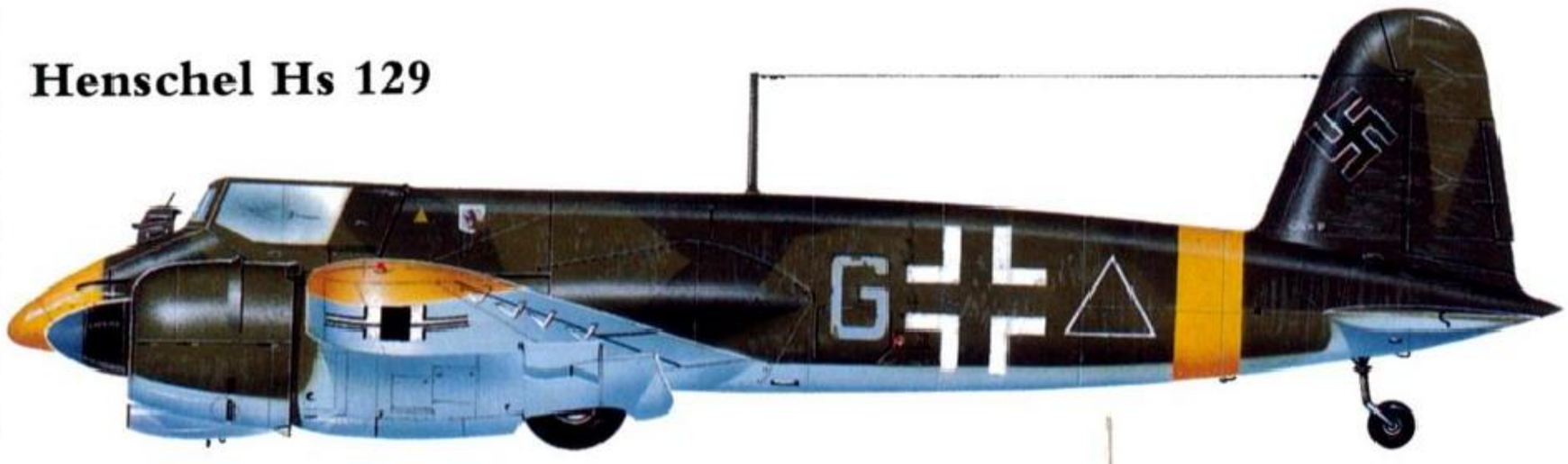
Below: The easternmost German railhead in Russia was at Chir, where these Bf 109s awaited evacuation although they were captured during the Stalingrad reversal. In the group are two II./SchlG 1 aircraft, together with JG 3 machines and wings from a Romanian aircraft.

Panzerjäger in action

Transferring to the control of Luftflotte 4 on the southern sector of the front in the early months of 1943, the operational Staffeln of the unit took up residence at Poltava and other fields between the Rivers Dnieper and Donets. Weiss established temporary headquarters on Khortitsa, an island in the Dnieper opposite the town of Zaporozhe. At first the Staffeln operated collectively as the 'Panzerjagdkommando Weiss'. From this was developed a special front-line command structure known as the Führer der Panzerjäger, which subsequently came to control all the various specialised anti-tank units operating on the Eastern Front.

Not that there were many such units. The Versuchskommando's operational trials soon led to the rejection of the Bf 110 and the Ju 88 as tank-busters. The latter was particularly heavy and unwieldy, especially when toting the lethal 75-mm BK 75 (whose muzzle compression had

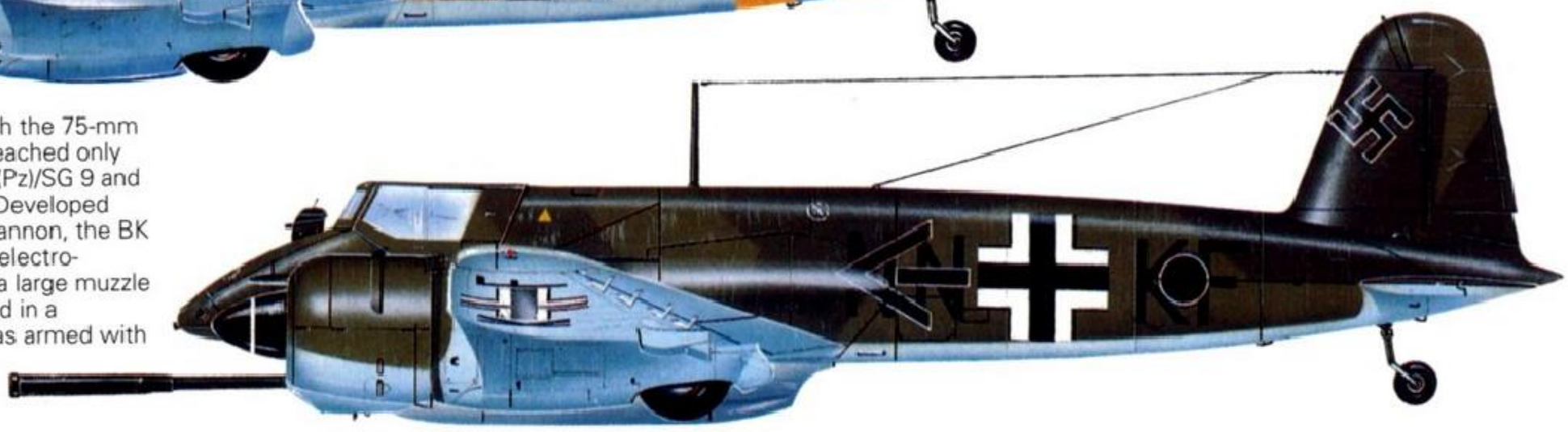
Henschel Hs 129



8./SchlG 1 was the fourth unit to equip with the Hs 129, following two in the east and one in North Africa. It was one of four Hs 129 Staffeln which flew co-ordinated attacks from Mikoyanovka during the great tank battles at Kursk in July 1943. This is an Hs 129B-1, the first production model. Compared to the Hs 129B-0, it introduced open blast troughs for the guns.

Wearing soluble white distemper winter camouflage, this Hs 129B-1 also served with 8./SchlG 1. In October 1943 the reorganisation of the Schlacht units led to the unit being redesignated as 11.(Pz)/SG 9, and soon after it was pulled back to Germany to act as a special trials unit.

This winter-camouflaged Hs 129B-2/R2 flew with IV.(Pz)/SG 9. The B-2 arrived on the production line in 1943, by which time the Hs 129 was being used as a dedicated anti-armour weapon rather than for general close support duties. Rüstsatz-2 (R2) installed a 30-mm cannon under the fuselage, and this soon became a standard factory fit, the aircraft being designated Hs 129B-2/Wa.



Hs 129B-3/Wa aircraft with the 75-mm BK 7.5 anti-tank cannon reached only two operational units, 10.(Pz)/SG 9 and 14.(Pz)/SG 9 (illustrated). Developed from the army's PaK 40 cannon, the BK 7.5 in definitive form had electro-pneumatic operation and a large muzzle recoil brake. It was housed in a jettisonable fairing and was armed with 12 rounds.

an unfortunate tendency to crumple the Junker's nose and bend its propeller blades).

In addition to further developments of the Hs 129, only the Ju 87 equipped with under-wing cannon was selected for production, 199 of the type being ordered as the Ju 87G-1. The Hs 129 and Ju 87 Staffeln of the 'Panzerjagdkommando Weiss' more than justified the confidence placed in them. As well as knocking out numerous tanks during their front-line trials, between April and June 1943 they destroyed over 1,000 Soviet landing craft and barges engaged in amphibious operations in the lagoons and along the Kuban coastline.

In June 1943 the parent Versuchskommando in Rechlin was disbanded and the operational Staffeln at the front dispersed to other units. Only the Ju 88Ps of Pz.J.St. 92, despite their earlier rejection, were retained for further experimentation as part of a combined Panzerjagdgeschwader, comprising a Gruppe each of Hs 129Bs, Ju 87Gs and Ju 88Ps, which it was planned to establish at the end of 1943. Although this particular project came to naught, cannon-armed Ju 88Ps were still around early in 1944; III.Gruppe of KG 1 'Hindenburg', a Ju 88-equipped Kampfgeschwader, conducted trials as an autonomous anti-tank unit on the type until its disbandment on 31 March of that year.

Before leaving the subject of ground-attack Ju 88s, brief mention should be made of the Zerstörerstaffeln operated by several other Kampfgeschwadern which were specifically employed on 'train-busting' sorties. The most notable of these was arguably 14.(Eis.)/KG 3 (Eis. being the abbreviation for Eisenbahn, i.e., railway), whose handful of Ju 88Cs roamed the hinterland of the central sector terrorising the Soviet rail network for much of 1944.

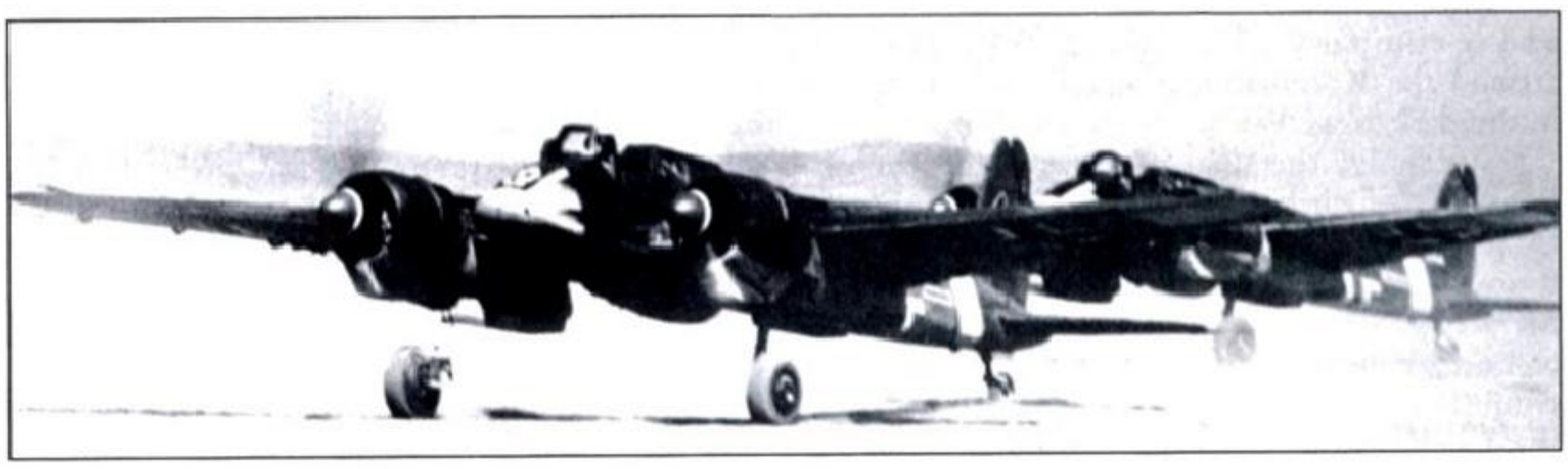
Perhaps the most amazing 'ground attack' machines ever to fly on the Eastern Front were those four-engined Heinkel He 177s of Major Heinrich Schlosser's I./KG 50. They had been impressed into service to airlift supplies into beleaguered Stalingrad and had been fitted with a 30-mm MK 101 cannon in an ungainly chin fairing to suppress troublesome Soviet flak positions en route.

The turning point

While the search for the definitive anti-tank aircraft had been underway, SchlG 1 continued its lone close support of 6.Armee as it crossed the Donets and advanced towards the River Don and beyond to the city of Stalingrad. Hermann Buchner, an NCO pilot of II.Gruppe, recorded some impressions as that long hot summer of 1942 slowly faded and winter took hold: "The ground troops were taking their objectives one after the other. Our operations ran like clockwork. Our daily bread: bombing sorties, low-level attacks, now and again a dogfight. The sun never stopped shining – real holiday weather.

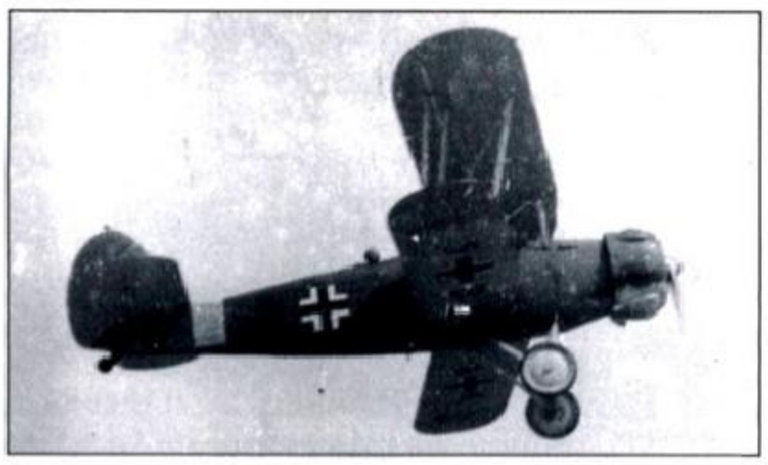
"After 10 days we again transferred further eastwards. Our new base was yet another forward landing strip, simply an enormous open field. Our Gruppe was assigned the eastern edge. The old routine – continuous sorties; reconnaissance, bombing, ground attack.

A rotte of Hs 129Bs of 8.(Pz)/SchlG 1 taxis in the dust for a summer mission. Both are carrying the ventral gondola for a 30-mm cannon, probably an MK 101. The nearest aircraft has the infantry assault badge painted on the nose.



Lying up under cover by day, this Gotha Go 145 of NSGr 5 on the Southern Sector would set out each night to harass Soviet troops.

Even the ancient Junkers F13 was impressed into anti-partisan duties. This example was seen at Prossnitz in Moravia in 1943.



The Sonderstaffel Buschmann was the forerunner of the Estonian NSGr 11. One of the types used was the Stampe SV-5, licence-built by VEF.

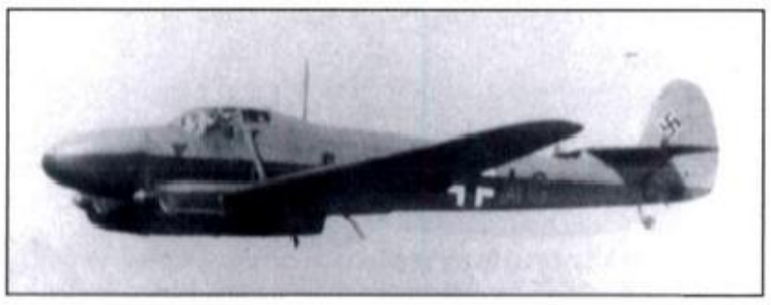
"These forward fields were always filled to bursting. Real ant's nests. Supplies usually came in by air on Ju 52s. As one landed, another took off. In between, the fighters, the Stukas and ourselves, the Schlächter. Everyone jockeying for position in the landing pattern and on the ground – organised chaos.

"Another move forward. This time things didn't go quite according to plan. The attack had been postponed, but nobody told the Luftwaffe. As we switched off our engines we could see the troops crouching in their foxholes still waiting for the signal to advance. I climbed out and asked the nearest group of infantry what the problem was. They explained that the attack had been delayed, that this was the front line, and would we kindly push off as quickly as possible before we attracted artillery fire.

"It was not a pleasant situation. The silence. The stillness. An empty sunlit field with a huddle of 109s plus several of our transport Ju's which had already followed us in with supplies and a company of pioneers. We gathered around the Kommandeur but he was as much in the dark as we were.

"Suddenly, the decision was made for us. Fountains of earth as the Russian artillery began to zero in on the field. The footsloggers were furious, gesturing at us to clear off. After only the second or third salvo one of the Ju's began to burn. It had received a direct hit. Complete confusion. We dashed to our 109s – no sign of the mechanics – and began to crank them up

This Heinkel He 50 served with NSGr 11. Planking was laid at many airfields to overcome the muddy conditions.



Painted with black undersides for nocturnal sorties, this Nachtschlacht Focke-Wulf Fw 58 also carries the Luftdienst (air service) emblem.

ourselves, arms going like demented windmills. Remove the crank handles, jump into the cockpit, switches, ignition – my engine roared into life. I quickly fastened my harness. The enemy fire was growing heavier by the second. High time to follow the infantry's advice and disappear. Nose into the wind, full throttle and back to our previous base at top speed.

"It was good to get back to some semblance of normality. One after the other the 109s came in to land. They were followed by the remaining Ju's, whose crews had hurriedly dumped their loads and taken off empty. So here we were, safe but hungry, while our field kitchen was back there being bracketed by Russian artillery. Some hours later a foot-sore column of mechanics, clerks, medics and cooks came trudging in. A lucky escape, after all.

"November. For some days past the entire front had been on the move. Our little circus kept pace. The previous evening a damaged He 111 had belly-landed in the middle of the field. In the morning our Staffel was to fly a dawn reconnaissance. At first light we taxied out, with me as No. 2 to the Staffelkapitän. We had all been informed of the He still sitting out on the field. But just as we were lifting off there was a sudden explosion and fireball to my left – the chief's machine had clipped the Heinkel and gone in.

"We carried out the mission. When we returned, a pillar of smoke was still rising above the field. Hans Stollnberger was appointed our new Staffelkapitän. The front moved forward. We transferred to Tazinskaya. A new era was beginning. The familiar routine within the Staffel was about to become a thing of the past."

Advance turns to retreat

Tazinskaya was just 200 km (125 miles) from Stalingrad. The 6.Armee's bitter, but ultimately unsuccessful, struggle to take the town on the Volga marked the limit of the ground troops' territorial gains in Russia. By association, it also heralded the end of SchlG 1's succession of steady (if not always smooth) advances from one featureless forward landing strip to the next. Hermann Buchner had been right; a new era was beginning. It was an era of retreats and withdrawals as the pilots of SchlG 1 retraced their steps, relinquishing every yard of ground they had fought over and won. Unlike the third of a million men who were to be surrounded,

On the left of this NSGr 3 group is Oberfeldwebel Ludwig Bellof, one of only four Nachtschlacht pilots to receive the Knight's Cross.

killed or captured at Stalingrad, they would live to fight another day.

They had made one last leap forward, to Kalach on the Don, little more than 50 km (30 miles) from the embattled city. In a desperate attempt to stem the tide of encircling Russians, and in blizzard conditions, they flew their final missions in support of the divisions they had accompanied for so long and so far across the dusty steppe. To no avail. Kalach itself was one of the first important towns to fall to the northern pincer of the Soviet counter-offensive launched on 19 November. SchlG 1 escaped the trap just in time.

The reversal at Stalingrad marked other changes, too. Despite its 18 months of service in the east, the Bf 109 was by no means the ideal machine for Schlacht operations under the primitive conditions which so often prevailed in Russia. A replacement had long been sought. With no new developments readily available, a decision had been taken during the weeks leading up to Stalingrad to produce a version of the Focke-Wulf Fw 190A fighter (which had entered service on the Channel front 12 months earlier) optimised for the close-support role.

It proved to be an inspired choice. The 190 was robust and reliable. It possessed a wide-track undercarriage which made it sure-footed in snow and ice (the undoing of many a spindle-shanked 109). In addition, its bulky air-cooled engine offered improved frontal protection for the pilots and made it far less vulnerable to enemy ground fire – stories would soon be circulating about 190s limping home with complete cylinder heads shot away.

In the late summer of 1942, II./SchlG 1 had begun withdrawing from the front for re-equipment on a Staffel-by-Staffel basis. By the year's end it had been decided that each Schlachtgruppe would be standardised on three Staffeln of 190s plus a fourth flying the twin-engined Hs 129.

Incredibly, the surviving Hs 123 biplanes were also still soldering on. A number of the Geschwader's pilots swore by their antiquated but apparently indestructible mounts, preferring the freedom of an open cockpit – even in the depth of a Russian winter – to the relative 'comfort' of a 109. Nor was the esteem in which the venerable 'eins-zwei-drei' was held restricted only to those who flew it. In January 1943, so highly did he value the services rendered by the handful of Hs 123s under his command – which, in times of crisis, could take off, minus wheel spats, through quagmires of mud and slush that were keeping every single one of his 109s and 129s anchored firmly to the ground – that the C-in-C Luftflotte 4, none other than Generaloberst Wolfram Freiherr von

NSGr 12 was Latvian-manned. Here standing in front of an Ar 66C is Zanis Tamsons, pictured at Liepaja (Libau) in 1943.

Celebrations are the order of the day for these NSGr 12 personnel, seen in front of an Arado Ar 66C night attacker at Jelgava, Latvia, in July 1944.

The He 46 observation platform was employed on Nachtschlacht and anti-partisan duties, notably with NSGr 7 operating in the Balkans.

In its infancy the Sonderstaffel Buschmann operated a handful of lightplanes. This is a PTO 4, designed and built in Estonia.

The Sonderstaffel Buschmann eventually became NSGr 11 (est.). It fought primarily on the Courland front, using this Fokker CV-E.

Richthofen, proposed in all seriousness that the type be reinstated in production. Unfortunately, Henschel had scrapped all the jigs and tools three years earlier.

Soon, aircraft even more ancient, and against which the Hs 123 was the very model of modernity, would be operating over the Eastern Front.

Under cover of darkness

In 1941 the Soviet air force had begun night harassment bombing, using light aircraft, predominantly the Polikarpov Po-2 (U-2) biplane. Usually flying singly – anything from five to 15 minutes apart – and at altitudes varying between 250 and 1500 m, these machines would prowl the German front lines and rear area routes of supply, searching for any sign of light or activity. Bomb loads were of necessity small, often dropped by hand in a silent glide with the engine switched off. Too slow to be easily intercepted by the few Luftwaffe night-fighters subsequently despatched to the Eastern Front, they were to prove a constant and sustained menace over the battlezone throughout the campaign. The knowledge alone of their unseen presence – sometimes the only prior warning of the arrival of a small fragmentation bomb would be the soft thrumming of the wind in the wires of a low-flying attacker – forced the German ground troops to take extra precautions and lost them a great deal of sleep. Among the more printable epithets they bestowed upon these night raiders were 'Nähmaschinen' (sewing machines), the 'UVD' (Duty NCO – i.e., the man whose job it was to rouse them each morning) and the 'Rollbahn-Huren' (highway whores – this latter a double reference to the fact that supply routes were a favourite target of the Po-2s, many of which were flown by women).

A thorn in the flesh of the soldier at the front they may have been, but it took Luftwaffe staffs a full year and more to realise (or perhaps to admit?) that such machines were playing an important role in the air war along the Russian front. It was not until the beginning of October 1942 that the Luftflotten in the east themselves suggested the setting up of similar units. Initially known as 'Behelfskampfstaffeln' (auxiliary bomber squadrons), each command was to establish its own Staffeln from within its existing organisation; the number created was dictated by the crews and aircraft which could be made available. The types equipping these early

Nachtschlacht – Nocturnal raiders

Having suffered for over a year from night nuisance attacks by Soviet Po-2 biplanes, the Luftwaffe established its own night units in October 1942, initially known as Behelfskampfstaffeln although soon rechristened as Störkampfstaffeln. In October 1943 they were regrouped into Nachtschlachtgruppen. In addition to harassment of the Soviet front lines and supply areas, the aircraft also undertook anti-partisan operations within German-occupied territory.

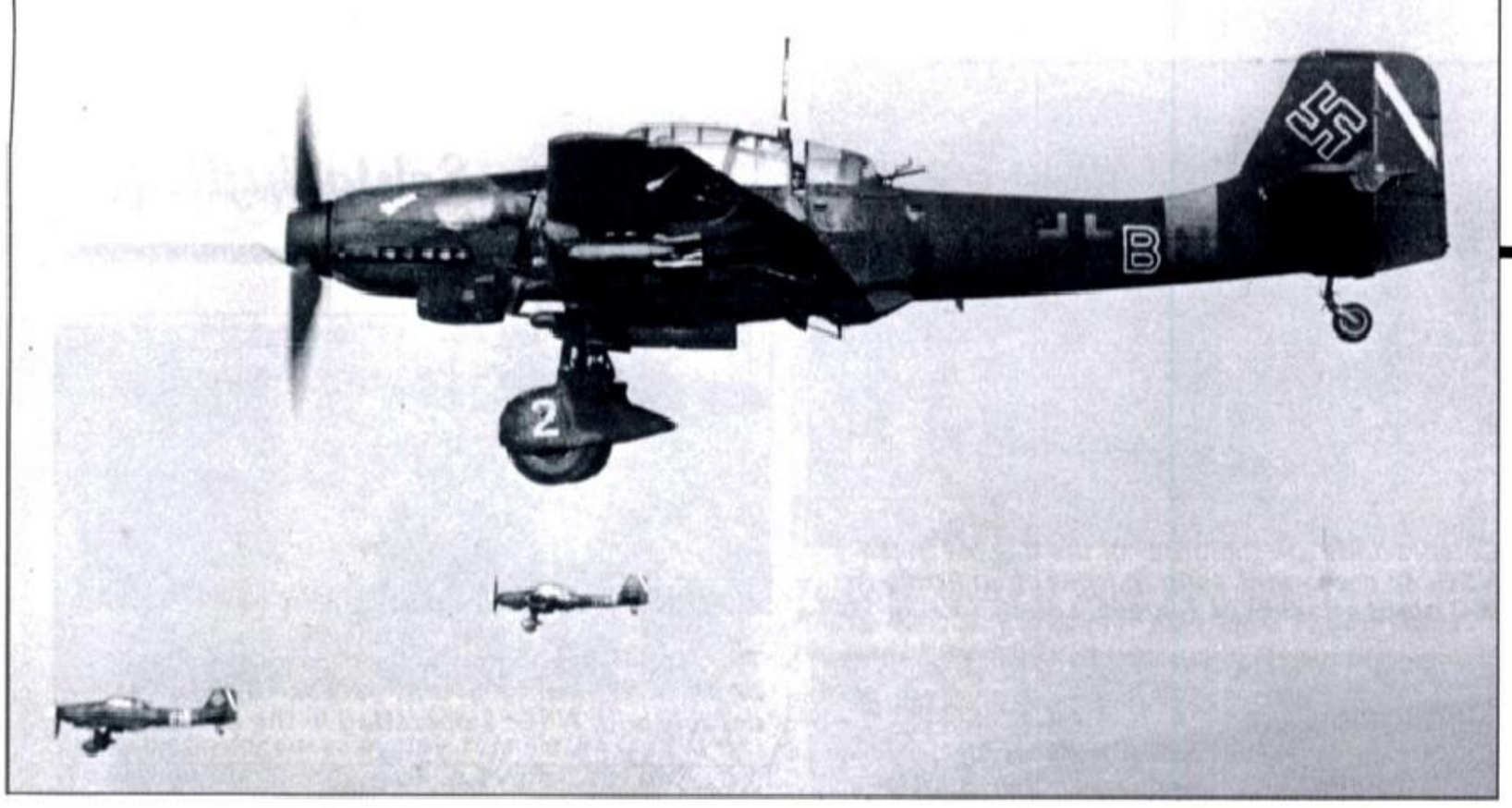
Heinkel He 46 (above)
This He 46c was assigned to 3.Störkampfstaffel in spring 1943, serving on the Southern Sector as part of Luftflotte 4. Note the small fuselage-mounted bomb rack.

Gotha Go 145 (above right)
Seen as it appeared in February 1944, this Go 145A served with 2./NSGr 3 at Pleskau on the Northern Sector as part of Luftflotte 1.

Fokker CV (below)
Operating from Rahkla in Estonia in August 1944 was this Fokker CV-E of NSGr 11. The aircraft had originally been operated by the Danish air force. In October 1944 it was flown by four defectors to Sweden and subsequently returned to its original owner in 1947.

Focke-Wulf Fw 58 (below)
Many of the Nachtschlacht aircraft were drawn from command liaison fleets. This Fw 58, wearing winter camouflage, operated with 1./NSGr 2 at Baranovici with Luftflotte 6 on the Central Sector during the winter of 1943/44.

Fiat CR.42 (above)
Operating under Fliegerführer Kroatien, this CR.42 flew with 3./NSGr 7 in June 1944 from Agram (Zagreb) on anti-partisan operations in the Balkans.



Ju 87D-3s of 4./SG 2 set out on a bombing mission. The D-3 was the first variant built as a Schlachtflugzeug, incorporating extra armour for the crew, engine and radiator. Ju 87s still retained their Stuka dive-bombing role.

The unspatted wheels of a 7./StG 1 Ju 87D kick up the mud on return from a mission, the empty fuselage bomb cradle swinging free.

With flame-damped exhaust and blacked-out markings, this Ju 87D-7 was employed on Nachtschlacht duties.

Staffeln were therefore generally drawn from the commands' pool of communications aircraft and light transports, most notably the Arado Ar 66, Gotha Go 145 and Junkers W 34.

Tasked with "disrupting the enemy by night by means of attacks on villages in the immediate vicinity of the front and on areas of forest or woodland known, or suspected, to be occupied by the enemy," the first units formed were redesignated in November to become 'Störkampfstaffeln' (harassment bomber squadrons). By the beginning of 1943, Luftflotte 1 on the northern sector of the front had established four such Staffeln, Luftkommando Ost in the centre deployed two, and Luftflotte 4 on the southern sector had set up six. As of 20 February, these dozen Staffeln had a combined strength of 236 aircraft, 148 of which were serviceable. These figures are representative of the Störkampfstaffeln's total numbers for much of the remainder of the year.

Störkampf miscellany

At first, each of the Staffeln operated a bewildering mix of aircraft, sometimes as many as five different types. The Heinkel He 46 and twin-engined Focke-Wulf Fw 58 'Weihe' were early additions to the original trio. As the year progressed, more 'modern' types began to appear on the nocturnal inventory: by June the Focke-Wulf Fw 189, Henschel Hs 126, Dornier Do 17 and even the Junkers Ju 87. A semblance of order was emerging, too, with some Staffeln standardising on just one type.

If the night harassment Staffeln were the poor relations in terms of aircraft allocation, there was one last collection of Eastern Front ground-attack units which was even further down the ladder.

Soviet partisan activity had broken out almost from the moment the first German troops crossed the border in June 1941 and began their advance eastwards. The further forward the front line moved, the greater the area left exposed in its wake. Soon vast tracts of territory – forests, woodlands, swamps – were providing safe havens for isolated pockets of Red Army stragglers and displaced civilians. The Soviet authorities encouraged and exploited their presence in the enemy's rear areas and began flying in weapons, supplies and trained personnel to organise guerrilla bands.

For their part, the Germans realised that air power would be invaluable in combating the partisans, but it was not until the spring of 1942 that aircraft could be spared from the front for use on such duties. By that time it was too late. The partisan movement had grown to such an extent that the penny-packets of second-line aircraft – sometimes just individual machines – detached in support of rear-area police actions were hopelessly inadequate for the job.

It was perhaps inevitable that the nocturnal harassment units, once established, would also become involved in these activities. In September 1943 Luftflotte 6 (as the Lw.Kdo.Ost had been redesignated four months earlier) set up a special command on the central sector under Generalmajor Josef Punzert to co-ordinate the Störkampfstaffeln in flying both harassment raids over the front lines by night and rear-area anti-partisan operations by day.

To supplement his meagre forces (which were responsible for policing an area almost the size of France), Punzert established several special units specifically to combat the growing menace of the guerrillas. Some were equipped on a par with front-line formations. 'Sonderstaffel Gamringer' for example, a mixed reconnaissance and attack squadron, included Ar 66s, Ju 87s and Bf 109s among its dozen aircraft. For other units, the barrel would appear to have been well and truly scraped. The three-Staffel strong 'Einsatzkommando Liedtke' also had the Bf 109 on strength, but then went rapidly downhill in the equipment stakes – via an assortment of obsolescent bombing and reconnaissance types – to the Junkers F 13. This flying museum piece, a single-engined commercial aircraft designed and first flown in 1919 (thereby pre-dating Polikarpov's Po-2 by a good nine years), must arguably be one of the oldest 'combat' aircraft ever to have served on the Eastern Front, if not in the entire annals of World War II.

Welcoming the 190

The flurry of activity surrounding the activation of the night ground-attack and anti-partisan units cannot disguise the fact that, by early 1943, SchlG 1 still remained the only true daylight ground-support formation on the Eastern Front.

The Geschwader utilised the post-Stalingrad period of retrenchment to complete its conversion from the Bf 109 to Fw 190s. By mid-March it was back with Luftflotte 4 on the southern sector of the front nearing full complement and under new leadership. Kommodore Major Hitschhold had been promoted to a senior staff position and his place at the head of the Geschwader was now taken by Major Alfred Druschel, who had led I.Gruppe for the past year. Druschel's old position was in turn filled by Hauptmann Georg Dörffel, a veteran member of II.(Schl)/LG 2. Unlike Dörffel's I.Gruppe, which comprised the standard three Staffeln of 190s plus a fourth of Hs 129s, II./SchlG 1 fielded only two 190 Staffeln; 7./SchlG 1 was still clinging grimly to its Hs 123 biplanes. (Since the previous October, incidentally, II.Gruppe had been commanded by Hauptmann Frank Neubert, an

Life on the Eastern Front: II./SchlG 1 pilot Feldwebel Hermann Buchner provides some entertainment at Tusow in 1942 while waiting for his socks to dry!

To make barely habitable accommodation even worse, this area at Tusow was overrun with sand vipers. Unteroffizier Lebsanft was II./SchlG 1's uncrowned 'king of the snake catchers'.

Henschel Hs 129B-2/R2
8./SchlG 1
Kursk offensive
Central Sector
June 1943

Despite early maintenance troubles with the aircraft, Hs 129Bs were active with four Eastern Front Schlachtstaffeln and a single specialist anti-tank unit – (Pz.J.St./JG 51 – by July 1943, when the type received its first real major action at Kursk. In October all five units were redesignated as Panzerstaffeln within SG 9. Three additional Hs 129 squadrons were formed within Grupul 8 Asalt of the Romanian air force, and they were later used sparingly against German forces after the Romanian coup in August 1944. By this time attrition and petrol shortages severely curtailed Luftwaffe operations, and the Hs 129 had largely disappeared by the spring of 1945.

Nose apertures
Early production B-2s were distinguished by having a central nose aperture for an Rb 24 automatic camera, while the port aperture was an intake for the weapons hydraulics heater.

Engines
The Hs 129A series was powered by the inline Argus As 410A-1 engine, but it was woefully short on power. The availability of the French 700-hp (522-kW) Gnome-Rhône 14M radial allowed the Hs 129B to partially redress this problem (although the aircraft always remained underpowered). However, the 14M was very unreliable and very sensitive to dust conditions and the slightest battle damage. Engines for each side were 'handed' (i.e. the propellers turned in opposite directions), which further complicated maintenance nightmares.

Fuel
Fuel was held in a 200-litre (44-Imp gal) tank behind the pilot, and in two 205-litre (45-Imp gal) tanks in the interspar void of the centre-section.

Bomb armament
Two SC 50 bombs or 24 SD 2 bomblets could be carried on underwing racks as standard. The R4 field modification allowed the carriage of centreline bombs (single SC 250, four SC 50s or 96 SD 2s).

Wing markings
The two diagonal stripes on each wing were guides for adjusting the flaps and ailerons when viewed from the cockpit. Also visible are the entry steps for the pilot.

Internal gun armament
Internal armament consisted of a pair of 20-mm MG 151/20 cannon in the upper fuselage sides (with characteristic bulge over the breeches), each weapon having 125 rounds. Below the cannon, mounted in the wingroots, were two 7.9-mm MG 17 machine-guns, each with 500 rounds. The latter were removed in the Hs 129B-3/Wa which featured the massive 75-mm BK 7.5 anti-tank gun.

External guns
The R2 field conversion depicted here added a 30-mm MK 101 cannon in a jettisonable pod under the centreline, with 30 rounds. The R3 fit had four uncowled MG 17 machine-guns under the centreline. Factory-built Hs 129B-2/Wa aircraft mostly had a 30-mm MK 103 cannon pod, although some were fitted with the 37-mm BK 3.7 (as used by the Ju 87G-1). Finally, the Hs 129B-3/Wa had the massive 75-mm PaK 40 or BK 7.5 gun.

Armour
To protect it and its pilot from the intense small-arms fire encountered in the low-level attack mission, the Hs 129 incorporated much armour. The entire nose section formed an armoured 'bath' for the pilot, built up from 12-mm plate on the undersides and 6-mm to the sides. The cockpit glazing was of 75-mm armourglass. Further armour was built into the engine nacelles.

Cockpit
The triangular section of the fuselage made the cockpit very cramped, with little room for instruments. The Revi C 12/C gunsight was mounted outside, while the engine instruments were located on the inner surfaces of the engine nacelles.

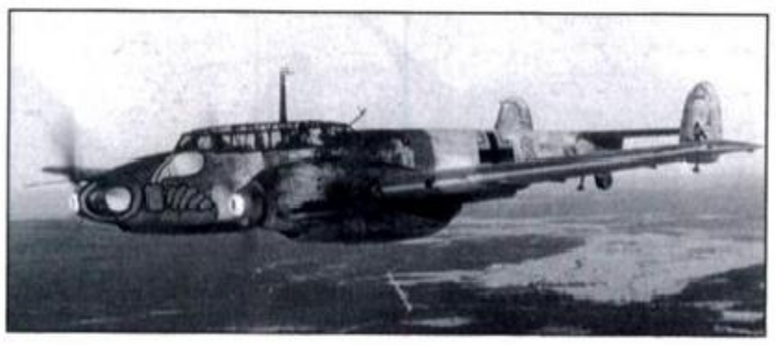
Camouflage
Most Hs 129s were delivered for Eastern Front service in standard Schwarzgrün/Dunkelgrün splinter camouflage, with yellow theatre bands and Hellblau undersides.

Markings
This aircraft wears the horizontal bar to denote II.Gruppe, with the individual code letter 'H'. The latter was repeated on the nose under the Infanterie-Sturmabzeichen badge. Red was rarely used as part of unit insignia or in coding to avoid confusion with the enemy.

Undercarriage
The single-strut main undercarriage retracted hydraulically into the rear of the engine nacelle, where a portion of the wheel was left exposed to minimise damage in the event of a wheels-up landing.

Above: A IV.(Pz)/SG 9 pilot runs up his winter-camouflaged Hs 129B-2/Wa at Czernowitz in March 1944. Of note is the 30-mm MK 103 cannon under the centreline, and the armoured backrest.

Right: Augmenting the work of the ground attack units was II./Schnellkampfgeschwader 210, which flew the Messerschmitt Bf 110 (a C-4/B illustrated) on bombing sorties. The Wespen nose marking was carried over from 1./ZG 1.



ex-Stuka pilot from StG 2 and the man credited with the Luftwaffe's first aerial kill of World War II: an unwary Polish PZL P.11c fighter west of Cracow in the early hours of 1 September 1939.)

During this period Luftflotte 4 also controlled all the specialised anti-tank Staffeln in service or undergoing operational trials. Occasionally, one or another of them would be temporarily subordinated to neighbouring commands. In January, for example, Pz.J.St/JG 51's quartet of serviceable Hs 129s had operated for a short period under Luftkommando Don. In March the two cannon-armed Ju 87 Staffeln of the Versuchskommando were detached to serve with Luftkommando Ost on the central sector.

On the northern flank, however, apart from II.(Schl)/LG 2's brief deployment to the Novgorod and Leningrad areas during the first autumn of the campaign, Luftflotte 1 had not had a single close-support unit under its control. Any ground-attack operations that were deemed necessary were delegated to the resident Jagdgeschwader. Such fighter-bomber missions were heartily disliked by the members of JG 54, however, and it was quietly agreed between them that any pilot who managed to write-off one of the detested Jabo machines in an 'emergency' landing would receive a crate of champagne from his fellows. All went well – apart from a distressingly high rate of attrition among the ranks of the Jabostaffeln – until one over-enthusiastic flyer ground-looped and ran into two other parked aircraft. For a while it was touch-and-go whether he would get three crates of liquid refreshment or a court martial. With the wisdom of Solomon, the Kommandeur turned a blind eye to the handing over of the champagne . . . and then ordered it distributed throughout the Staffel.

Above: In 1943 Schlachtflieger losses began to mount. Here wounded await evacuation by Ju 52.

Below: In the far north, 14.(Jabo)/JG 5 – later 4./SG 4 – mounted anti-shipping attacks along the Arctic and White Sea coasts. The Staffel was commanded by Hauptmann Friedrich-Wilhelm Strakeljahn, who went on to command II./SG 4 in Italy before moving back to the East in June 1944.

Kursk

During the late spring and early summer of 1943, SchlG 1's two Gruppen operated over the Kuban bridgehead and their old stamping grounds east of Kharkov. Preparations for a third German summer offensive were already underway. This year, however, there were to be no great advances and grandiose objectives; no Moscow as in 1941, no Stalingrad and Caucasian oilfields as in 1942.

Recent Soviet counter-pressure had already driven the Wehrmacht back to its approximate line of mid-1942, but with one vital difference. West of the town of Kursk the Russian advance had formed a huge bulge. Shaped like a gigantic fist, and measuring 180 km (110 miles) from top to bottom, it threatened to smash the central sector wide open. The aim of the 1943 German offensive (codenamed Operation Zitadelle) was to eliminate the Kursk salient by simultaneous attacks from both north and south, isolating and destroying the 11 Soviet armies trapped within. The resulting Battle of Kursk, launched on 5 July 1943, would be the largest armoured confrontation in the history of warfare – and the greatest challenge yet for the Luftwaffe's Schlacht and anti-tank units.

As part of Luftflotte 4's support for 4.Panzer-Armee on the southern flank of the salient, SchlG 1 was based at Varvorovka near Byelgorod. It was there in the south that the deepest penetration into the Soviet defences were made. The Fw 190s' primary task was to attack enemy anti-tank positions and artillery emplacements with the deadly new SD-1 and -2 cluster bombs: these containers scattered either 180 or 360 small fragmentation bomblets over a wide radius, with devastating effect. Meanwhile, the Geschwader's two Hs 129 Staffeln, aided by two others – Pz.J.St./JG 51 and 4.(Pz)/SchlG 2 (the latter recently arrived from Africa after re-equipment at Berlin-Staaken) – targeted the Soviet armour.

Stukas at Kursk

Another unit in the area was Stukageschwader 2 'Immelmann', to which was attached one of the two experimental cannon-armed Ju 87G anti-tank Staffeln. The Kapitän of 1./StG 2 already had experience of the 87G, flying it over the Kuban bridgehead where he had destroyed 70 Soviet landing craft. His name was Hans-Ulrich Rudel. There now began a partnership between Rudel and the Ju 87G which would last until the end of the war, by which time his incredible tally of successes – which ranged from the sinking of a battleship to the disabling of four armoured trains – would include the destruction of over 519 enemy tanks.

On the northern flank of the salient there were just two anti-tank units: the other Ju 87G Staffel (attached to StG 1) and the cannon-equipped Bf 110s of Pz.J.St./ZG 1. It was there that a Soviet counter-offensive began to threaten the rear of the attacking German forces. On 19 July Russian tanks blocked the Orel-Bryansk railway and endangered 9.Armee's major supply route. Most of the Luftwaffe's southern sector ground-support units – which had already been instrumental in halting an armoured attack on II.SS Panzerkorps' exposed flank – were rushed

A pair of Fw 190F-8s sets out on a mission. Each is armed with a single AB 250 cluster bomb dispenser. Bombs were often delivered in a Steckrubenwerf ('turnip lob'), the Fw 190 approaching at very low level before popping up to 1,000 ft. The pilot then made a shallow dive towards the target, lifting the nose some 3° about a second before bomb release to ensure the weapon cleared the propeller.

Left: A weary 'black man' (mechanic) snatches 40 winks between missions during the battle of Kursk. The Jabo Fw 190A is from the Gefechtsverband Druschel.

A Jabo-Rei (long-range fighter-bomber) Fw 190A-5/U8 lifts off with a single SC 250 bomb. The Fw 190G was the definitive Jabo-Rei version, with reduced gun armament and drop tanks.

northwards to contain this latest threat. Their performance is best summed up by the telegram of appreciation sent to Luftwaffe HQ by Generaloberst Walter Model, GOC 9.Armee: "... for the first time in the history of the war the Luftwaffe, without any support from the ground whatsoever, has succeeded in stopping and destroying a complete armoured brigade."

... for the last time, too. Operation Zitadelle was called off by order of the Führer on 20 July. There would be no more great summer offensives. The initiative had passed finally and irretrievably into the hands of the Soviets. A floodtide was about to be unleashed that would not be halted until it reached the heart of Berlin. Although the coming months would see a dramatic increase in their numbers, never again would the Schlacht units of the Luftwaffe be called upon to mount a concerted response.

Reorganisation

Despite the ultimate failure of Zitadelle, both Schlächter and Panzerjäger had performed outstandingly. Rudel, who had knocked out a dozen Soviet tanks by the end of the first day of the battle, was particularly impressed by the Ju 87G's potential: "The evil spell is broken. Here is a weapon capable of dealing with the growing numbers of enemy tanks. We quickly evolve our tactics. While the cannon-armed machines go in to attack the tanks, the other Stukas suppress the ground defences. Unlike them, our angle of attack must not be too steep. A shallow dive; otherwise there is a danger of overshooting and hitting the ground. The best method of approach is from the rear. The best target to aim for is the thinner plate of the engine decking. It is normally perforated for cooling purposes. And where the engine is, there the petrol is, too."

Individual successes – even those as incredible as Rudel's – were at best just drops in the ocean. As Soviet pressure increased along the entire length of the front from the Gulf of Finland to the Black Sea, ground support in the east underwent a fundamental change. Pilots who had spent the previous two years spearheading the advances of their own victorious Panzers would – if they survived – remember the coming two as a constant succession of withdrawals and increasingly bitter rearguard actions.

SchlG 1 remained on the central sector in the immediate aftermath of Zitadelle (during which time the last Hs 129 Staffel, 8.(Pz)/SchlG 2, also arrived in-theatre from the Mediterranean) before returning to the south for the fourth and final battle for Kharkov. This time the town, one of the major German bastions on the southern front, changed hands for good, being recaptured by the Red Army on 23 August. Between sorties, the pilots had watched swelling numbers of ground troops retiring westwards along the main highway outside their Kharkov-Rogan base before they, too, withdrew to Pol-Rudka, an airfield north of Poltava.

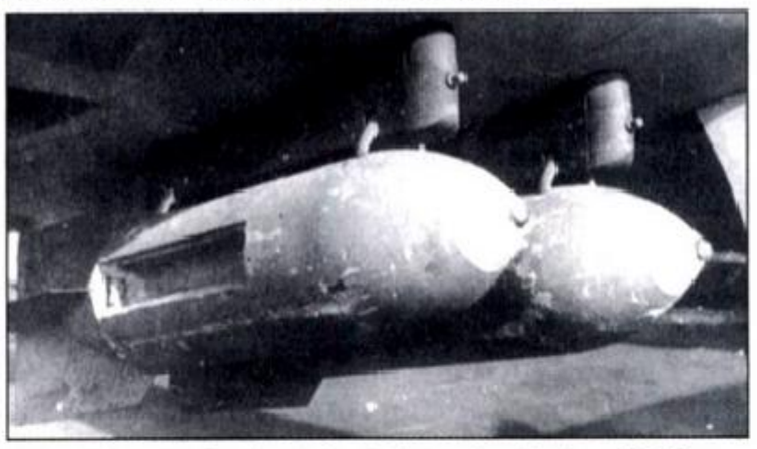
The Geschwader's months of isolation as the only close-support unit in the east were now nearing an end. Faced by an enemy army of seemingly inexhaustible strength and reserves, the German High Command – as part of an attempt to maximise its own far-from-abundant resources – decreed that the Luftwaffe's three hitherto separate tactical aviation branches be combined under a single command. Until this time the Ju 87 dive-bombers of the Stukageschwader (still by far the most numerous, though ageing, force of the three) had operated as part of the bomber arm, while the fighter-bombers of the Schnellkampfgruppen and the Schlacht units had been controlled by the Inspectorate of Fighters. With effect from 18 October 1943 all three were amalgamated under a newly established General der Schlachtflieger, a post held briefly by Oberstleutnant Dr Ernst Kupfer, erstwhile Kommodore of StG 2 'Immelmann' until his death in an air crash the following month, and thereafter filled until the war's end by SchlG 1's own Generalmajor Hubertus Hitschhold.

The redesignation of the five existing Stukageschwadern (StGs 1, 2, 3, 5 and 77) as Schlachtgeschwadern – henceforth to be abbreviated to the more simplified SG – meant the

Close-support weapons

A wide variety of weapons were employed by the Schlacht units, many tailored to the anti-personnel role. Many novel systems were tested, although bombs, cluster units and guns remained the major weapons.

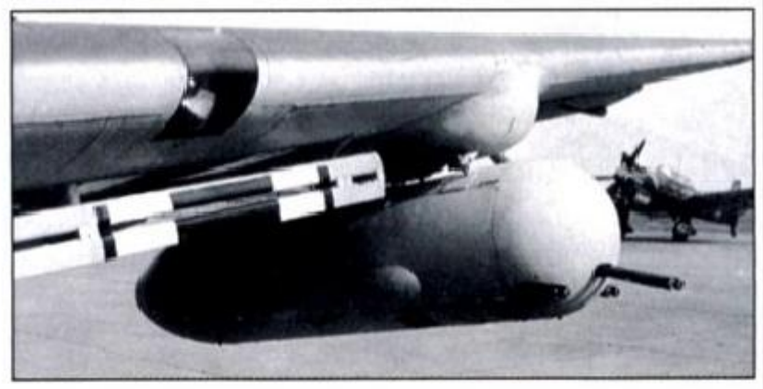
The AB 250 cluster weapon was effective and versatile. The canister split in two while in flight, scattering the sub-munitions.



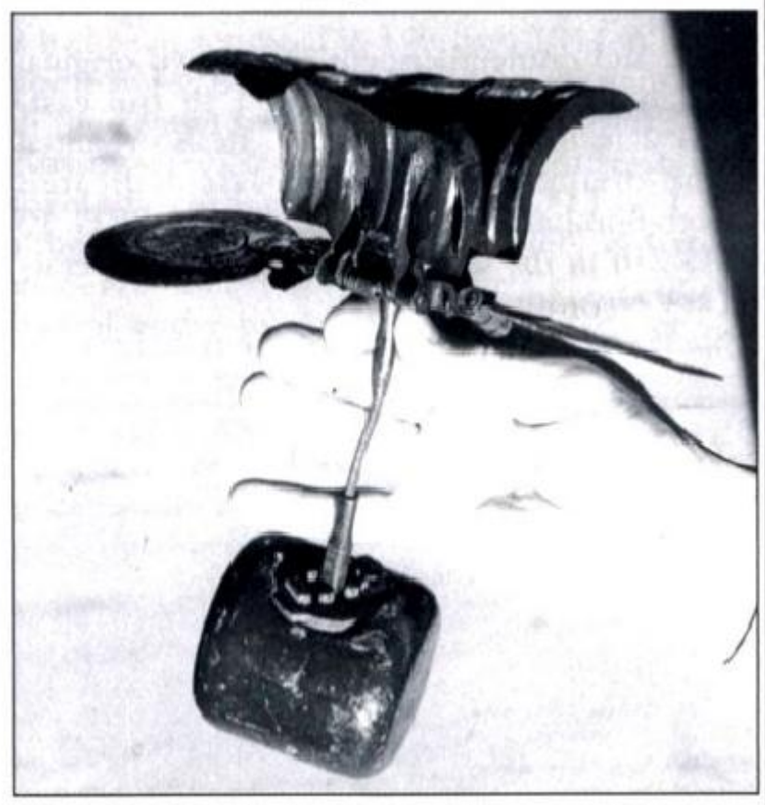
Most Fw 190Fs had the Rüstsatz-1 kit, with four ETC 71 racks under the wings for SC 50 bombs. This weapon was the most widely used bomb.

The Fw 190F had a centreline ETC 501 rack, which could carry a single SC/AB 250 or mount an ER 4 adaptor for four SC 50s.

This Ju 87D-7 (with flame-damped exhaust) carries the Universal Behälter, a container which could drop bomblets through trap doors.



This Ju 87D-1 carries the Waffenbehälter WB 81 (known as the 'watering can'), which contained six 7.9-mm MG 81 machine-guns, angled downwards for strafing.



The 2-kg SD 2 'butterfly bomb' was used in large numbers. On release the wings opened and the minelet fell slowly to the ground.

Schlachtflieger

Oberfeldwebel Hermann Buchner (left) flew 611 Schlacht ops before converting to the Me 262 jet, in which he scored 12 bomber kills.

Hans-Ulrich Rudel achieved a massive tally of victories, but was himself shot down many times. He lost a lower leg but continued flying.

Major Alfred Druschel was Kommodore of SchlG 1 at the time of Kursk, and later became inspector of Day Schlacht Forces.

Hauptmann Hans Stollnberger scored 45 aerial victories and escaped from Russian captivity by swimming the Don at night.

Above: By September 1943 Soviet fighters were exacting a toll on the Schlachtflieger. This scene in the Ukraine shows two young cowherds perching on an unusually-marked Fw 190.

Left: An immaculate line of Fw 190F-2s of SchlG 1 waits at Deblin-Irena in Poland prior to its transfer to the front. Several aircraft carry the Mickey Mouse badge.

The Ju 88C-6 was used as a train-buster, this example being from 4./KG 76, seen in early 1943. The fake nose glazing was applied to give the appearance of a bomber to enemy fighter pilots rather than a heavily-armed fighter.

demise and dismemberment of the two original Schlachtgeschwadern (SchlG 1 in the east, SchlG 2 in the Mediterranean). It also resulted in the disappearance of the last dedicated fighter-bomber unit, the Italy-based SKG 10 (SKG 210 in the east having long been operating as a reconstituted ZG 1).

Such was the complexity of the redesignation process that it is perhaps best, and most concisely, illustrated by the following table:

I.-III./SG 1	previously	I.-III./StG 1
I./SG 2	previously	I./StG 2
II./SG 2	previously	II./SchlG 1
III./SG 2	previously	III./StG 2
10.(Pz)/SG 2	previously	Pz.J.St./StG 2
I.-III./SG 3	previously	I.-III./StG 3
I./SG 4	previously	II./SchlG 2
II./SG 4	previously	II./SKG 10
III./SG 4	previously	III./SKG 10
I./SG 5	previously	I./StG 5
I./SG 10	previously	I./SchlG 2
II./SG 10	previously	IV./SKG 10
III./SG 10	previously	II./StG 77
I./SG 77	previously	I./StG 77
II./SG 77	previously	I./SchlG 1
III./SG 77	previously	III./StG 77
10.(Pz)/SG 77	previously	Pz.J.St./StG 1

One Stukagruppe did not undergo redesignation at this juncture. It remained operational as a specialised anti-tank unit and was carried on Luftflotte 4's order of battle as II./StG 2(Pz) before, in March 1944, being used to create the two new Ju 87G-equipped anti-tank Staffeln: 10.(Pz)/SG 3 and 10.(Pz)/SG 77. The latter replaced the above-listed 10.(Pz)/SG 77 which then returned to its parent unit as 10.(Pz)/SG1.

18 October 1943 did see the five Eastern Front Hs 129 Staffeln organised into a single anti-tank Gruppe by renaming the office of Führer der Panzerjäger as the Stab IV.(Pz)/SG 9 with its Staffeln made up as follows:

10.(Pz)/SG 9	previously	4.(Pz)/SchlG 1
11.(Pz)/SG 9	previously	8.(Pz)/SchlG 1
12.(Pz)/SG 9	previously	4.(Pz)/SchlG 2
13.(Pz)/SG 9	previously	8.(Pz)/SchlG 2
14.(Pz)/SG 9	previously	Pz.J.St/JG 51

Command of the Gruppe was assumed by Hauptmann Bruno Meyer, a veteran Hs 123 pilot from the days of Fliegergruppe 20 and the Munich Crisis, and more recently combat leader of the four Hs 129 Staffeln engaged in the Battle of Kursk.

One final round of redesignations took place on 18 October 1943: the 'upgrading' of the night harassment Störkampfstaffeln into Nachtschlachtgruppen. On the northern sector Luftflotte 1's four Staffeln were paired off into NSGrs 1 and 3, with the three central sector Staffeln of Luftflotte 6 forming NSGr 2, and Luftflotte 4 in the south dividing its six Staffeln into NSGrs 4, 5 and 6.

Two other Nachtschlachtgruppen were activated on the same date. NSGr 7 was formed locally in Croatia, primarily for day reconnaissance and nocturnal anti-partisan operations in that area. It became only peripherally involved

Junkers Ju 87G-1

This BK 3.7-armed Ju 87G served with 10.(Pz)/SG 3 at Jakobstadt in Latvia during 1944. Ju 87Gs served with seven Staffeln, including all three of III./SG 2.

Focke-Wulf Fw 190

This Fw 190F-2 was the mount of Leutnant Fritz Seyffardt, depicted as it appeared in the Ukraine in May 1943, shortly after Seyffardt's unit, 6./SchlG 1, had returned to the front after converting to the Fw 190 from the Bf 109. Seyffardt subsequently flew with 5./SG 2 before becoming Staffelkapitän of 12./SG 151. He survived the war, still flying on ground attack duties against the Russians, having amassed 30 aerial victories in addition to many successes against ground targets.

The double chevron markings give this Fw 190F-2 away as a Gruppenkommandeur's aircraft, in this case Major Heinz 'Allan' Frank of II./SG 2. Frank was a veteran of the Schlacht units, having flown Hs 123s in Poland and France. He died in hospital in October 1944 after his pistol accidentally discharged. His aerial victory tally was eight.

Oberfeldwebel Otto Dommeratzky was one of the flamboyant veterans of the Schlachtflieger, having flown attack missions from 1939 in Poland to 13 October 1944, when he was shot down on a ferry flight (along with a mechanic who had stowed himself in the rear fuselage), one of several experienced Luftwaffe pilots to fall on the Russian front to the guns of USAAF Mustangs. 'Black T' was his Fw 190F-2 when he was flying with 8./SchlG 1 in the Kiev area in September 1943.

This Fw 190F-2 was assigned to Hauptmann Georg 'Orge' Dörffel, Gruppenkommandeur of I./SchlG 1, seen as it appeared in February 1943 at Kharkov. Dörffel scored 30 aerial victories in the east before serving in Italy, where he was killed. The aircraft carries the triangle markings of the ground attack arm, worn ahead of the fuselage cross to distinguish I.Gruppe. The individual aircraft codes were unusually worn behind the cross.

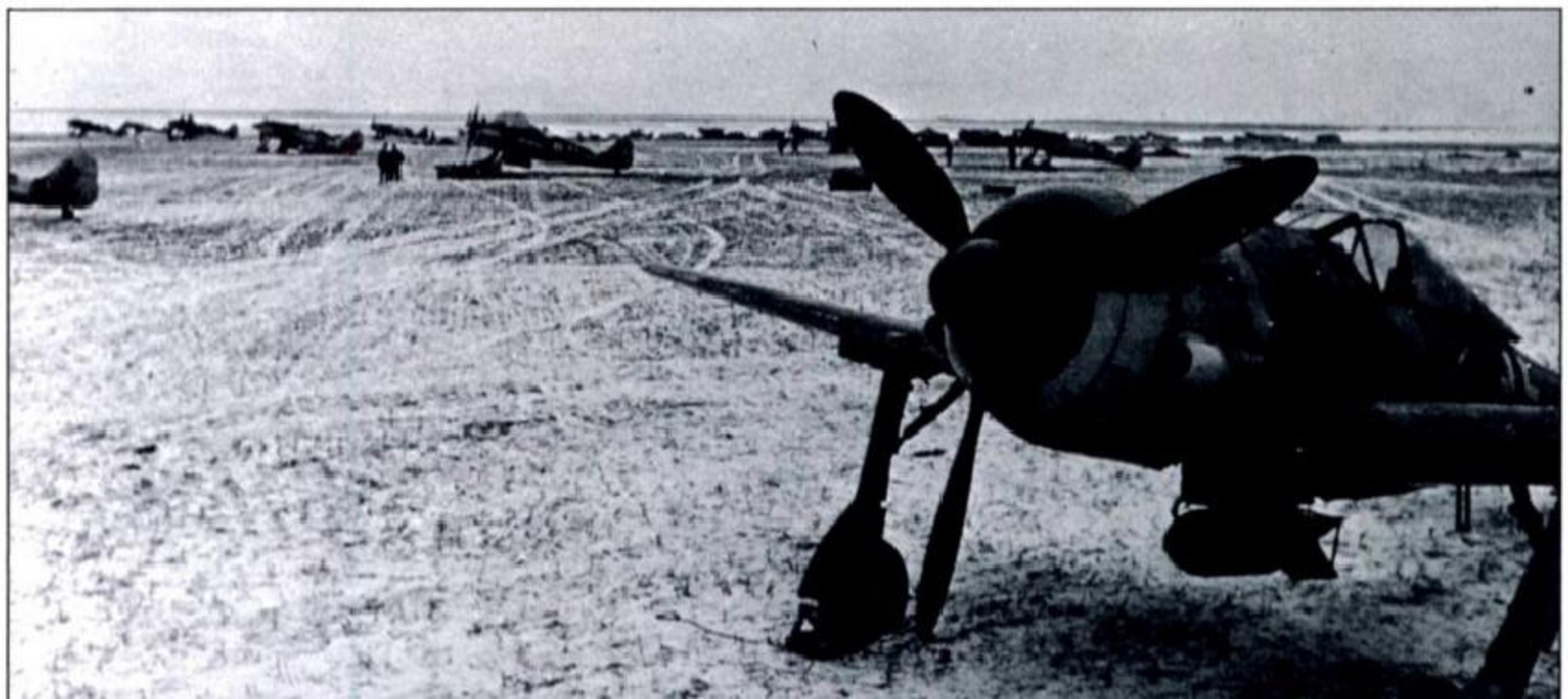
Carrying an AB 250 cluster bomb, this Fw 190F-9 was the mount of Major Karl Kennel, Gruppenkommandeur of II./SG 2, depicted as it appeared at Börgönd in Hungary in the winter of 1944. The hastily applied camouflage was primarily to deter attacks on the ground. The yellow wing chevron was the standard identification markings for the Hungarian theatre.

One of a handful of Fw 190D-9s issued to Schlacht units, this 'Dora' was the mount of Oberst Hans-Ulrich Rudel, Geschwader-kommodore of SG 2 and the most highly-decorated German soldier of the war – he was the only recipient of the Golden Oak Leaves. Having flown Ju 87s for most of the war, Rudel did fly a few missions in the Fw 190 at the end of the war. Buried insignificantly in his huge tally of successes against ships and ground targets were nine aerial victories.

on the Eastern Front during the closing stages of the war. NSGr 11(est.) was a unit composed of Estonian volunteers whose history dated back to June 1942 and the creation of the 'Sonderstaffel Buschmann', a small reconnaissance formation that operated a colourful mix of light aircraft along the Baltic coastal provinces. It was later expanded into SAGr 127, a combined maritime reconnaissance and harassment Gruppe, which in turn became NSGr 11 (est.) and was based in Courland until its disbandment in October 1944.

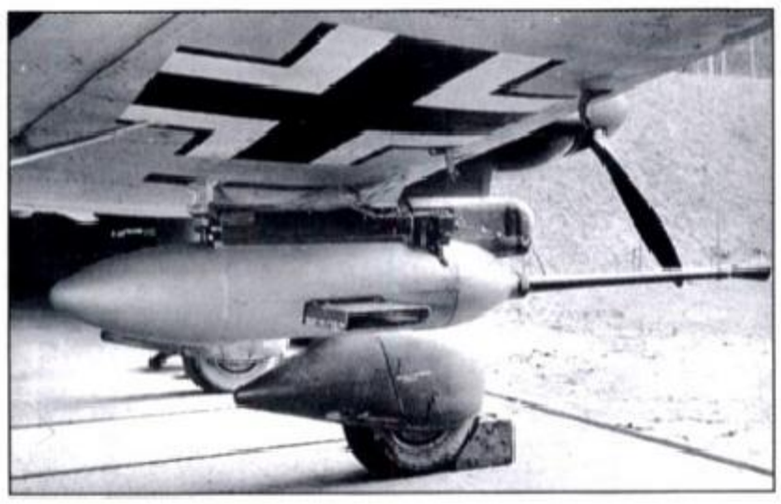
During the 12 months of NSGr 11's existence, four more Eastern Front night harassment units were brought into being. The first of these was perhaps the most intriguing of all. The 'Ostfliegerstaffel', activated in December 1943, was formed of Russian volunteers – presumably ex-POWs. Equipped with captured Soviet light aircraft – the Polikarpov Po-2 and Yakovlev UT-2 – together with Arado Ar 66s and Gotha Go 145s, it first operated under Luftflotte 1 in the north before transferring with its five serviceable machines (one of each type, plus a spare?) to Lida, near Mogilev on the central sector, in March 1944. It was disbanded there five months later. It was in March, too, that a third volunteer unit was formed, the Latvian NSGr 12 (lett.). Like the Estonians, they also fought on the Courland front until disbandment in October.

The last two Nachtschlachtgruppen to operate against the Soviets served on opposite extremities of the Eastern Front and remained in action until the cessation of hostilities. NSGr 8 had been activated in February 1944 in the far north and was based in Finland until transferred to the central sector and the Berlin front in the closing weeks. NSGr 10, by contrast, was formed from elements of II./LLG 1 (an airborne Gruppe) at Agram (Zagreb) in Croatia in September 1944. After first carrying out several glider-tug operations, the Gruppe's Ju



Much of the terrain in the east was bleak and featureless, and the temporary landing grounds offered little comfort. Despite the dusting of snow, the Gruppen-adjutant's aircraft in the foreground is fitted with a tropical filter.

Although it was slow and vulnerable, and increasingly needed fighter cover from Fw 190s, the Ju 87G-1 was one of the most effective tank-killers on the Eastern Front, especially in the hands of experts such as Rudel. The aircraft carried a modified 37-mm Flak 18 (BK 3.7) cannon under each wing (below right) with a characteristic case ejector chute on the outboard side. One is seen below left under test in the butts. The aircraft above is from 10.(Pz)/SG 77, one of the last two operators of the Ju 87G.



87s then flew night ground-attack missions in the north Balkans and Hungary, ending the war at Graz in Austria.

The wholesale redesignations of 18 October 1943 did not, of course, mean the sudden reinforcement of the Eastern Front by 15 new Schlachtgruppen at a single stroke. Discounting those units initially retained in the Mediterranean theatre (SGs 3, 4, and 10), the others all carried on very much as before; equipped with Ju 87 dive-bombers, carrying out dive-bomber operations – remaining Stukageschwader in all but name.

The process of conversion to the Fw 190 proved to be a lengthy and protracted business. The first Gruppen to be re-equipped – I. and III./SG 1, commencing in March 1944 – enjoyed the benefit of withdrawal from the front line and six to eight weeks at schools back in Poland in which to complete their training. As the war entered its final 12 months, such luxuries could be ill-afforded. Courses grew progressively shorter, instruction sketchier. By the end of 1944 the pilots of the last Gruppe to convert, III./SG 2, had to be content with two or three Fw 190 familiarisation flights sandwiched between the hectic round of daily operations from their forward bases in Hungary. Not all achieved even this. At the time of the surrender, III./SG 2 was still equipped with a few war-weary Ju 87 dive-bombers.

The Geschwaderkommodore's markings identify this aircraft as Hans-Ulrich Rudel's personal Ju 87G-1, WkNr 494193. The aircraft is carrying the Southern Sector wrap-round chevron markings.

Fighting retreat

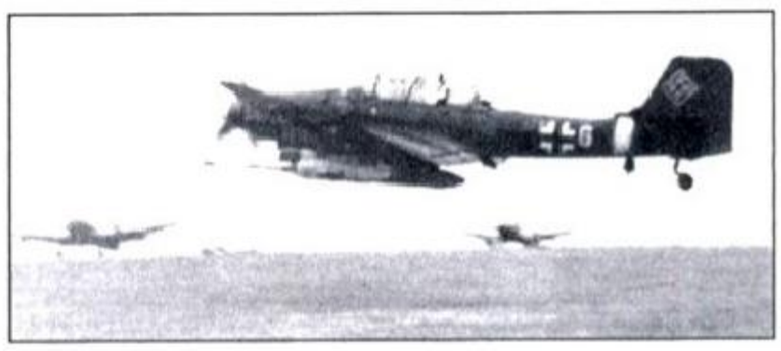
For the two original Schlachtgruppen it was still therefore very much business as usual. Since their retreat to Pol-Rudka late the previous summer, the pilots of the erstwhile II./SchlG 1 – now operating as II./SG 2 – had been forced into further withdrawals. Early January 1944 found them back behind the Dnieper on a landing strip to the west of Kirovograd. Here at Malaja-Wieska (inevitably, 'Malaya-Whisky' to its new occupants) they had perhaps their narrowest escape of all.

Hermann Buchner related: "We were sharing the field with a Gruppe of Bf 109 fighters. The depth of winter. Poor visibility and light snow showers. The situation on the ground wasn't exactly rosy, either. Division after division streamed past us, pulling out to the south-west. We had our hands full; in constant action against the advancing Soviets. We were a real thorn in their sides, and retribution wasn't long in coming. During the night of 13 January an enemy armoured spearhead managed to break through to our base.

"We were woken by the Adjutant about midnight – our quarters were in the deserted schoolhouse of a nearby village – and ordered to make our way individually to the field. We gathered around our aircraft dispersed on its western edge, awaiting the signal from HQ – a green flare – to blow them up to prevent them falling into enemy hands. Meanwhile, it was bedlam over on the eastern perimeter.

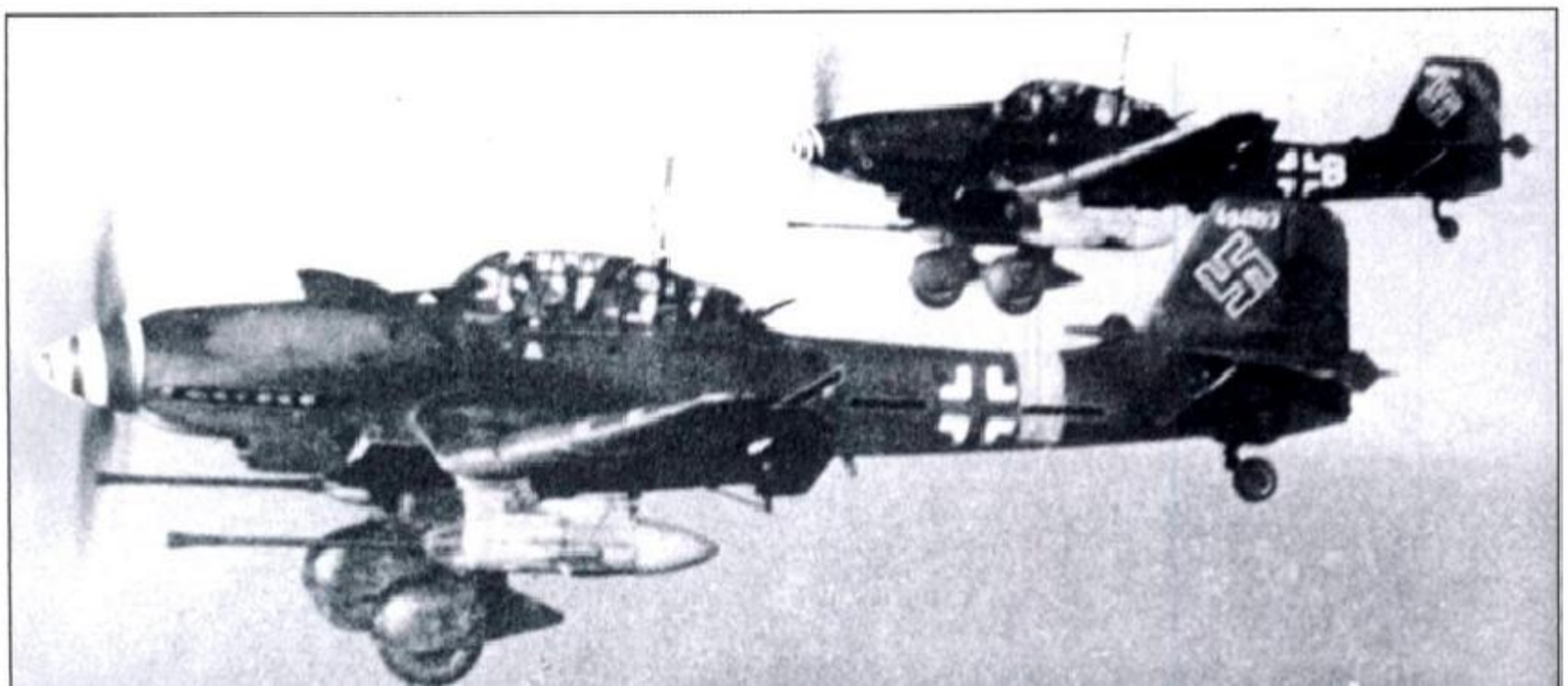
"A figure loomed out of the darkness. A fighter pilot to tell us that eight of his Staffel's machines had been destroyed by Russian tanks driving over them and crushing their tails. Our quadruple 20-mm flak vehicles set off across the field to tackle the accompanying enemy infantry while the base's own heavier 88-mm weapons engaged the tanks over open sights, with considerable success.

"We stood around all night, frozen stiff, awaiting orders. Towards dawn the noise of the battle slowly began to die down. At first light a trio of low-flying He 111s, obviously intent on bombing the field thinking it was in enemy hands, were warned off at the last moment by



Above: Having been hit by flak, the pilot of this Ju 87G has elected to jettison the undercarriage and attempt a landing on the cannon pods, using them as makeshift skis.

Below: With large numbers of enemy vehicles, and vast open steppes in which to hunt them, the Schlachtflieger were rarely short of targets. This truck was towing artillery until it was caught by Fw 190s from SchlG 1 near Stalingrad.



Focke-Wulf Fw 190F-8 1./Schlachtgeschwader 2 'Immelmann' Varpalotta, Hungary

Although rightly regarded as one of the best fighters of the war, the Fw 190 also emerged as a potent ground attack weapon, far better than the Ju 87 which it largely replaced on the Schlacht units. The F-1, F-2 and F-3 were based on the airframes of the Fw 190A-4, A-5 and A-6 respectively, while the Fw 190F-8 was based on the A-8 fighter, and featured fuselage-mounted 13-mm MG 131 machine-guns, resulting in the characteristic bulges forward of the windscreen. This aircraft is depicted as it appeared in the summer of 1944, when Luftflotte 4 was embarked on a slow and hard-fought retreat through Romania and Hungary. At this time the Fw 190s began to encounter USAAF P-51s flying long-distance missions from bases in Italy, in addition to the attentions of the massed ranks of Soviet fighters.

Armour protection
In addition to the standard armour of the Fw 190A-8 fighter, the F-8 employed additional protection against ground fire. This comprised 5-mm plates either side of the cockpit, 5-mm plate under the fuel tanks, 8-mm plate at the rear of the fuel tanks, 6-mm armour under the engine and 30-mm armoured windscreens and side windows.

Fw 190F production
Initial F production covered around 550 F-1s, F-2s and F-3s, running between late 1942 and mid-1943, when production shifted to the Fw 190G long-range bomber. The need for more Schlacht aircraft saw the F reinstated (in F-8 form) in the spring of 1944. Dornier and Arado built virtually all of the Fw 190Fs, and F-8 production accounted for 385 machines. The BMW 801TS-powered Fw 190F-9 appeared from mid-1944.

Canopy
Based on feedback from combat Schlacht pilots, the F-8 featured a bulged canopy for improved visibility.

Markings
This aircraft wears a standard Schwarzgrün camouflage with Hellblau meander pattern oversprayed. The yellow underwing and rear fuselage theatre bands were standard.

Weapon trials
The Fw 190F-8 was used for a variety of experimental weapon trials. These included: the SG 113A Förstersonde installation consisting of two 77-mm recoilless downward-firing guns in each wing, triggered electro-magnetically as the aircraft flew over a tank; SG 116 Zellendusche with a trio of vertically-firing MK 103 cannon or five MG HF/15 guns; three Panzerschreck (tank terror) 88-mm rocket tubes under each wing; a Panzerblitz 1 canister under each wing, each wooden container housing eight rockets; underwing Panzerblitz 2 racks for six or seven 55-mm R4M rockets with hollow-charge warheads; X4 Ruhrstahl and X 7 Rotkäppchen wire-guided missiles; and the BV 246 Hagelkorn glider bomb. Other F-8s were tested with BT 700 and BT 1400 torpedo bombs and LT F5 torpedoes for the anti-shipping role.

Bombload
The Fw 190F-8 was equipped with a single ETC 250 bomb rack (for an SC 250 bomb) on the centreline and four ETC 50 racks under the wings as standard. The centreline rack could mount, as here, an ER 4 adaptor to carry four small bombs, raising the total to eight SC 50 50-kg (110-lb) weapons. Another commonly used weapon was the AB 250 cluster bomb, which various types of sub-munitions (*splitterbombe*). These included 224 SD 1s, 144 SD 2 'butterfly bombs', 30 SD 4s, 17 SD 10s, 184 B 1 incendiaries and 116 B-2 steel-nosed incendiaries.

'Black men' work to prepare a Jabo Fw 190A-5/U3 Trop, possibly of II./SG 2, for a close support mission. They are loading an AB 250 container.

our recognition flares. At around 10.00 our flak, aided by local army units, succeeded in sealing off the breach. We all heaved a sight of relief. Our Fw 190s had remained unscathed."

A few days later II./SG 2 transferred to the Crimea. The peninsula was now isolated from the main front and dependent on air and seaborne supplies. The Gruppe stayed in the Crimea for four months. Despite being cut off the men remained supremely confident. "Our 190s were a match for anything the enemy had. They feared us, but respected us. We would move base and a couple of days later up would pop our old opponents, the Yak-9s – more 'Heroes of the Soviet Union' than you could shake a stick at. We knew each other well, and were familiar with each other's tactics."

Slowly, the Gruppe's role was changing. They found themselves increasingly employed as fighters: flying in mixed formations with the Bf 109s of neighbouring JG 52 against marauding bands of Ilyushin Il-2 Sturmoviks, and providing the fighter escort for Major Hans-Ulrich Rudel's cannon-armed Ju 87s. Pilots such as the gung-ho Otto Dommeratzky were no longer censured for seeking combat with the enemy. The number of aerial victories claimed by the Gruppe's veterans rose dramatically, but a relative newcomer was to put them all in the shade. After nearly five years as an instructor, 5.Staffel's Leutnant August Lambert had already achieved 20 kills since arriving on the Eastern Front in April 1943. In just three weeks during the battle of Sevastopol, he increased that total to 90 – including 17 in one day. He alone accounted for over a third of the 247 enemy aircraft claimed by II./SG 2 during its time in the Crimea.

Oberfeldwebel Otto Dommeratzky his seen in the cockpit of his 8./SchlG 1 Fw 190F-2 in the summer of 1943. The aircraft is beginning to show real signs of the pace of operations in the east.

It was not all mud, cold and intense combat: here 6./SG 2 pilots relax with a couple of local girls at Khersones, near Sevastopol, in 1944.

Escape from Crimea

Their eventual evacuation from the peninsula (where they finally bid farewell to the last of their Hs 123s) and transfer to Romania in the late spring of 1944 coincided with the belated build-up of ground-attack forces on the Eastern Front. Until then the wholesale redesignations of the previous autumn had shown very few concrete results. By the beginning of 1944 Luftflotte 4 on the southern sector had been the only one to receive any infusion of new strength; the two original Schlachtgruppen (now operating as II./SG 2 and II./SG 77) had been reinforced by the arrival of I. and II./SG 10 from the Mediterranean, a grand total of 76 serviceable Fw 190s in all. In addition, Luftflotte 4 fielded 35 Hs 129s of IV.(Pz)/SG 9, a dozen machines of the same type operated by the attached Romanian VIII.Schlachtgruppe, and a trio of tank-busting Ju 87s of 10.(Pz)/SG 2. Hardly an impressive line-up to combat the massive Soviet armoured thrust – backed by over 3,000 front-line aircraft of four entire air armies – which had just been launched to drive the Germans from the Ukraine.

In May the ex-Stukagruppen began returning to the front equipped with their new Fw 190s. Stab and III./SG 1 were the first to reappear on the central sector, followed by II.Gruppe in June. SGs 3 and 4 (the latter, incidentally commanded until just before then by the same Heinrich Brücker who had led the very first Hs 123 'Stukakette' in Spain in 1936) transferred to Luftflotte 1 on the northern flank from the Mediterranean in July. August saw Luftflotte 4 in the south further reinforced by I./SG 2, I./SG 77 and III./SG 10; all now operating the

An Fw 190 (probably an F-2) taxis across a snowy airfield, the pilot receiving a guiding hand from a ground crewman. The wide-track undercarriage allowed the Fw 190 to operate with some ease from the rough forward airstrips, although even it could not overcome the thickest mud or snow.

Fw 190. By September, with I./SG 5 flying in from Finland to take up residence at Schmilten in Latvia under Luftflotte 1, Focke-Wulf Schlacht strength on the Eastern Front had reached its peak of 15 Gruppen: 425 machines, 326 of them serviceable.

Thus, with but minor variations in the months ahead, the battle lines had been drawn. Unfortunately, it was all too little too late. On 21 June 1944, three years to the day since Barbarossa, the Soviets unleashed Operation Bagration (named after a Russian national hero in the war against Napoleon), a gigantic pincer movement aimed at crushing German forces in the central sector, liberating the last remaining areas of enemy-occupied Soviet territory and paving the way for the drive through Poland and the ultimate conquest of Berlin. Bagration dwarfed every other Soviet offensive to date. Its direct air support consisted of over 5,500 aircraft drawn from five air armies plus another 1,000 bombers of the strategic force. Luftflotte 6's three Fw 190 Gruppen and two Staffeln of anti-tank Ju 87s were powerless in the face of such overwhelming opposition. In less than two weeks Germany's Army Group Centre had lost nearly as many men as had been sacrificed at Stalingrad, and the entire front was in full retreat. By the end of July Soviet spearheads were on the Vistula and threatening the East Prussian border.

To the south, the Red Army's progress was less spectacular. As Luftflotte 4's units slowly gave ground across Romania and back into Hungary, they began to encounter a new enemy: fighters of the 15th US Air Force based in Italy. One of the Americans' first victims was Hauptmann Günther Müller, Staffelkapitän of 4./SG 2, whose Fw 190 was shot down in a dogfight with the fighter escort of a 15th AF bomber formation near Ploesti on 23 June. A month later, on 22 July, two more veterans of II./SG 2 fell to roving US fighters over Romania: another Staffelkapitän, 6./SG 2's Oberleutnant Ernst Beutelspacher, east of Focsani, and Feldwebel Erich Müller near Zilistea. The Gruppe's 190s may have been 'a match for anything the enemy had' in the recent past, but the USAAF's North American

Above: This picture graphically illustrates the desolation of many of the forward bases, in this case Khersones in April 1944. The pall of smoke marks a downed Soviet fighter.

Right: The Hs 129 continued in the east for most of the war. This 8.(Pz)/SchlG 2 aircraft carries a bundle of 10-kg SC 10 bombs under the wing.

P-51 Mustangs were another matter entirely.

The fighters and Schlächter of Luftflotte 4 were, in effect, among the first to experience the 'war on two fronts' – facing the Russians, with the Americans at their backs – to which the whole of the Eastern Front would soon be subjected. Losses rose accordingly. None was more keenly felt among the pilots of II./SG 2 than that of the irrepressible Otto Dommeratzky, whose tally of aerial victories was nearing the 40 mark when he was bounced by US fighters on 13 October 1944. Tragically, he was flying an unarmed machine on a transfer flight far behind the lines, with his chief mechanic stowed uncomfortably in the rear fuselage without a parachute. Rather than bailing out himself, Dommeratzky attempted unsuccessfully to crash-land the stricken Focke-Wulf and both men perished.

Trapped in the Courland pocket

Meanwhile, the success of the Soviet armies on the central sector had effectively cut off the units of Luftflotte 1 to their north. The northern flank of the Eastern Front had remained relatively static for much of the campaign, with little evidence of the war of movement – the sweeping advances, the dogged retreats – which had been waged across the southern steppe. With the lifting of the 900-day siege of Leningrad on 17 January 1944, the German army there was also being forced into full-scale withdrawal. For the first six months of the year there were practically no close-support aircraft attached to Luftflotte 1. Fifteen anti-tank Ju 87s of 10.(Pz)/SG 3 had put in a brief appearance in March, while between June and August the Fw 190s of I./SG 5 were deployed to Finland as part of the 'Gefechtsverband Kuhlmey', a mixed formation sent to counter renewed Soviet pressure in the Karelian Isthmus.

By October, however, German forces had retreated into the Baltic states and remained sealed within the shrinking perimeter of the Courland Peninsula for the remainder of the war as the Red army swept past to their south.

Initially, there were three Fw 190 Schlachtgruppen based in Courland: II. and III./SG 3 and III./SG 4. They operated almost exclusively in the close-support role for, as Leutnant Werner Gail of III./SG 3 explained, unlike the southern sector, "Only rarely did we come into contact with Russian fighters. I personally saw them on only two occasions and on neither did we lose an aircraft."

Instead, the Fw 190 pilots – soon reduced to just III./SG 3 – were kept fully occupied blunting each of the six successive, but entirely separate, offensives launched by Soviet ground forces between October 1944 and March 1945 in their efforts to eliminate the Courland pocket. Against the enemy infantry they employed their 20-mm cannon and the murderous SD fragmentation bomblets. Against the Russian tanks they used 250-kg and 500-kg bombs, approaching at an altitude of about 2000 m to avoid the light flak before dropping down to less than 10 m from the ground and running in at speeds of around 450 km/h (280 mph). The bombs would be released just as the target disappeared beneath the Focke-Wulf's nose, and would then either 'skip' off the ground and into the tank, or else slam straight into it. A single-second delay fuse enabled the aircraft to get clear before the target exploded.

Successful as these tactics were, the units trapped in Courland were entirely reliant on sea

The soft ground left by the spring thaw often necessitated the removal of mainwheel covers, as illustrated by this pair of Fw 190F-2s or -3s.

An increasingly common event as the war progressed: here SG 2 pilots are buried at Prossnitz (Moravia) in September 1944, after falling victim to USAAF P-38s.

Ground-Attack Units, Eastern Front, September 1944

The right-hand column refers to the number of aircraft on strength (first figure) and number of aircraft serviceable (second figure)

Central Sector

Luftflotte 6 (HQ Brunnstadt/Silesia)

14.(Eis)/KG 3	Kroszevo	Ju 88C	10-7

VIII.Fliegerkorps (HQ Vitkovice/Moravia)

Stab SG 77	Cracow	Fw 190	6-6
I./SG 77	Cracow	Fw 190	41-22
II./SG 77	Naglovichi	Fw 190	23-13
10.(Pz)/SG 77	Cracow	Ju 87G	20-15
10.(Pz)/SG 9	Warzyn	Hs 129	13-13
NSGr 2 (minus 1.)	Czestochowa	Ju 87	38-14
NSGr 4 (minus 1.)	Balice	Ju 87, Go 145	42-27
1./NSGr 5	Stubendorf	(re-equipping)	
14.(Eis)/KG 27	Stubendorf	He 111	14-12

1. Fliegerdivision (HQ Topolova/Poland)

Stab SG 10	Bielice	Fw 190	5-2
II./SG 10	Bielice	Fw 190	33-24
I./SG 1	Modlin	Ju 87	39-24
1./NSGr 2	Nasielsk	Ju 87	9-7
3./NSGr 4	Litzmannstadt	(re-equipping)	

4. Fliegerdivision (HQ Goldap/East Prussia)

Stab SG 1	Lobellen	Fw 190	5-4
II./SG 1	Lobellen	Fw 190	37-31
III./SG 1	Insterburg	Fw 190	26-20
10.(Pz)/SG 1	Hüttenfelde	Ju 87G	22-11
I./SG 10	Insterburg	Fw 190	39-31
III/SG 77	Hüttenfelde	Ju 87	22-11
Stab IV.(Pz)/SG 9	Jürgenfelde	Hs 129	6-6
12.(Pz)/SG 9	Jürgenfelde	Hs 129	13-13
13.(Pz)/SG 9	Jürgenfelde	Hs 129	14-14
NSGr 1 (minus 1.)	Wormditt	(re-equipping)	
1.kroat.SSt	Eichwalde	(in transit)	

Southern Sector

Luftflotte 4 (HQ Debrecen/Hungary)

I. Fliegerkorps (HQ Görgenyoroszfalu)

Stab SG 2	Görgenyoroszfalu	Fw 190, Ju 87	3-1
I./SG 2	Görgenyoroszfalu	Fw 190	13-11
II./SG 2	Görgenyoroszfalu	Fw 190	29-18
III./SG 2	Görgenyoroszfalu	Ju 87	26-25
10.(Pz)/SG 2	Görgenyoroszfalu	Ju 87G	4-3
III./SG 10	Görgenyoroszfalu	Fw 190	11-11
14.(Pz)/SG 2	Görgenyoroszfalu	Hs 129	12-9
NSGr 5 (minus 1.)	Kronstadt	Go 145, Ar 66	27-26

Northern Sector

Luftflotte 1 (HQ Malpils, Latvia)

3. Fliegerdivision (HQ Veselava)

Stab SG 3	Poltsama	Fw 190	2-2
II./SG 3	Riga-Spilve	Fw 190	33-27
III./SG 3	Poltsama	Fw 190	20-13
10.(Pz)/SG 3	Walmar	Ju 87G	12-12
Stab SG 4	Wenden	Fw 190	5-3
I./SG 4	Wenden	Fw 190	20-14
II./SG 4	Riga-Spilve	Fw 190	26-20
III./SG 4	Walmar	Fw 190	26-18
I./SG 5	Schmilten	Fw 190	22-11
1./NSGr 1	Segewald	Ju 87	17-14
NSGr 3	Blome	Go 145, Ar 66	33-30
NSGr 11	Rahkla	He 50, Ar 66, Hs 126, Fokker CV	39-36
NSGr 12	Riga-Spilve	Ar 66, Hs 126	26-18

Hungarian AF Units

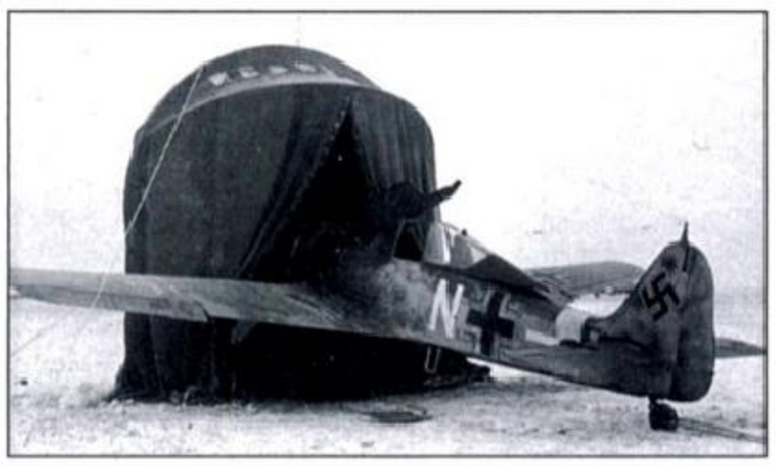
Fliegerführer 102 ung. (HQ Ungvar)

Schlachtstaffeln

ung. 1.SSt	Saraspatak	(re-equipping)
ung. 2.SSt	Veszprém	(re-equipping)

Nachtschlachtstaffeln

ung. 1.NSST	Ungvar	He 46, Fw 58
ung. 2.NSST	Hajdúböszörmeny	



Above and left: Scenes from a snowy airfield, showing the gaggle of huts (above) which acted as the Gruppe HQ and ops room, and a portable servicing shelter (left). Very few of the latter were available and they were highly prized by the mechanics. Their use negated the need to start fires under the engines to get them started on very cold mornings.

and air for all their supplies, as had been those in the Crimea before them. In Courland the situation soon became critical, particularly the dwindling stocks of aviation fuel. At the height of the defensive battles III./SG 3 would perhaps be called upon to fly as many as five missions a day. At other times the Focke-Wulfs had to be towed to and from their dispersals by teams of oxen. By early 1945 the Gruppe hardly flew at all.

Fuel-starved defenders

Elsewhere, the fuel situation had not yet reached such crisis proportions. As the general fuel shortage began to make itself felt throughout the Luftwaffe towards the close of 1944, it was this – more than any shortfall in pilots or aircraft – which reduced the Schlachtflieger's operations to the level of nuisance raids. They continued to score individual local successes, but these were mere pinpricks. As the most famous of them all, Hans-Ulrich Rudel, was later to admit, "We were no more than a boulder, a small obstruction but unable to stem the tide."

In order to maximise the effects of the missions they did fly, new weapons were introduced. Two of Luftflotte 4's anti-tank Staffeln, 10. and 14.(Pz)/SG 9, received new Hs 129B-3s equipped with the 75-mm BK 7.5 cannon in a huge ventral gondola. Carrying 12 rounds, this gun could knock out even the giant Josef Stalin tanks. In October 1944 the Fw 190s of 5./SG 77 in Hungary were among the first to be armed with rocket projectiles. Six of the so-called 'Panzerschreck' missiles, developed from the infantry's recoilless 88-mm bazooka-type weapon, could be carried by each aircraft. Other Staffeln to be similarly equipped included 6./SG 2 and 1./SG 10. Two months later the even more powerful 'Panzerblitz', based upon the R4M rocket fitted with an enlarged, hollow-charge warhead, was first issued to 7./SG 4 at Udetfeld.

During the winter months the Hs 129s received some highly individual camouflage schemes. The pilots' faces are beginning to show the strain.

A 'Panzerblitz'-armed Fw 190 was a potent weapon, as one pilot recalled: "By this time the Russians were employing hordes of Stalin tanks to lead their attacks. One in five of these was an anti-aircraft tank with turret-mounted quadruple 20-mm flak guns. We usually singled these out first. Once they were disposed of, we could concentrate on the rest. For a T-34, a single salvo of three rockets was normally sufficient. For a Josef Stalin the entire load of 14 rockets – fired from a distance of 100-150 m at just over 200 km/h – was required. If your aim was good, you could blow the turrets off these monsters. But then you had to watch the flying debris, which could be deadlier than the flak fire."

On 7 January 1945 a new anti-tank Gruppe, I.(Pz)/SG 9, was formed by redesignating three existing Staffeln. At Perleberg 12.(Pz)/SG 9 converted from its Hs 129s to the Fw 190 'Panzerblitz' to become 1.(Pz)/SG 9; the 2. and 3.Staffel positions were filled by the hitherto semi-autonomous and Ju 87G-equipped 10.(Pz)/SG 1 and 10.(Pz)/SG 3, respectively. The Kapitän of the latter, Hauptmann Andreas Kuffner, was promoted to command the new unit.

Finis

By this stage, such organisational niceties had little relevance. Germany's position was hopeless. Its Eastern Front allies had fallen one by one to the advancing Soviets, although Luftflotte 4's 'loss' of the Romanian Hs 129

A pair of II./SG 2 Fw 190s (possibly A-5/U3 Jabos, but both retain the wingroot cannon usually removed on this variant) waits with SC 250s for their pilots. Note the aircraft in the foreground, which has the mainwheel covers removed to avoid slush build-up, yet it is fitted with a tropical filter!

Schlacht Pilots with 500+ Missions

	Missions	Units	Aerial Victories	Fate
Major Werner Dörnbrack	1,118	LG 2, SchlG 1, 2, SG 4	29	–
Oberstleutnant Georg Dörffel	1,004	LG 2, SchlG 1, SG 4	30	KIA 26/5/44
Major Karl Kennel	957	(ZG 2), SchlG 1, SG 152, 2	34	–
Major Heinz Frank	900+	LG 2, SchlG 1, SG 2, 151	8	7/10/44(+)
Hauptmann Günther Müller	900	LG 2, SchlG 1, SG 2	–	KIA 23/6/44
Oberfeldwebel Ludwig Bellof	approx. 800	NSGr 3	–	–
Oberst Alfred Druschel	approx. 800	LG 2, SchlG 1, SG 4	–	KIA 1/1/45
Leutnant Herbert von Hoffer	700+	LG 2, SG 2, 77, 10, (JG 400)	9	–
Hauptmann Josef Menapace	700+	LG 2, SchlG 1, 2	2	KIA 6/10/43
Oberfeldwebel Bruno Schulz	approx. 700	SchlG 1, SG 77, 152	–	KIA 25/8/44
Leutnant Hermann Buchner	631	SchlG 1, SG 2, (JG 7)	58	–
Hauptmann Johannes Gehrmann	600+	LG 2, SchlG 1, SG 77	–	KIA 27/1/44
Oberfeldwebel Ehrenfried Lagois	600+	LG 2, SchlG 1, SG 2	–	KIA 15/4/44
Leutnant Hans-Georg Lohmayer	600+	SchlG 1, SG 77	–	KIA 22/10/44
Hauptmann Rudolf Smola	600+	(NAGr 15), SG 2, 151, 3	–	KIA 27/3/45
Oberfähnrich Erwin Gutzmann	approx. 600	SchlG 1, SG 2, 10	–	KIA 10/4/45
Oberleutnant Ernst Beutelspacher	approx. 600	LG 2, SchlG 1, SG 2	–	KIA 22/7/44
Leutnant Otto Dommeratzky	approx. 600	LG 2, SchlG 1, SG 2	approx. 38	KIA 13/10/44
Oberleutnant Jürgen Harang	approx. 600	SchlG 1, SG 77, 4	–	MIA 20/1/45
Hauptmann Hans Stollnberger	approx. 600	LG 2, SchlG 1, SG 4, 10	45	–
Feldwebel Klaus Riebicke	592	LG 2, SchlG 1, SG 77, 10	–	KIA 6/6/44
Hauptmann Franz-Karl Theyerl	587	Störkampf, NSGr 5	–	–
Oberleutnant Willi Tritsch	approx. 580	LG 2, SchlG 1, SG 151, 152	20	–
Oberfeldwebel Rudi Wendt	approx. 570	SchlG 1, SG 2	–	–
Oberfeldwebel Josef Enzensberger	550	SchlG 2, SG 10	–	–
Major Rupert Frost	approx. 550	(KG 27), Störkampf, NSGr 4, 9, SG 151	–	–
Leutnant Heinrich Starke	516	SchlG 1, SG 2, 77, 10, 151	16	–
Hauptmann Johannes Meinicke	500+	SchlG 1	–	KIA 4/9/43
Feldwebel Erich Müller	500+	SchlG 1, SG 2	–	KIA 22/7/44
Oberleutnant Stephan Schmitt	500+	SchlG 1, SG 77	2	MIA 7/10/44
Oberst Otto Weiss	500+	LG 2, SchlG 1	–	–
Oberleutnant Fritz Seyffardt	500	SchlG 1, SG 2, 152, 151	30	–
Major Bruno Meyer	approx. 500	LG 2, SchlG 1, 2, SG 9	–	–

In addition to the above dedicated Schlachtflieger, a number of the ex-Ju 87 Stukaflieger who transitioned to the Fw 190 after October 1943 also flew treble-figure missions on the latter type, most notably:

	Fw 190 Missions	Total Missions	Units	Aerial Victories
Leutnant Kurt Plenzat	approx. 600	1,234	StG 2, SG 2	4
Hauptmann Alexander Gläser	approx. 525	1,123	StG 77, SG 77	–
Oberst Hans-Ulrich Rudel	430	2,530	(2/(F)/121), StG 3, 2, SG 2	9

Above information extracted from Die Ritterkreuzträger der Luftwaffe 1939-1945, Vol/ II; *Ernst Obermaier; Mainz 1976*

Two of II./SG 2's Knight's Cross holders, Oberleutnant Ernst Beutelspacher (left) and Leutnant August Lambert (right). The latter was the highest-scoring aerial ace of the Schlachtflieger, with 116 kills to his credit.

Leutnant Werner Gail of SG 3 stands in front of his Fw 190F. The aircraft is draped in camouflage netting, often necessary at the exposed Eastern Front airfields.

Gruppe in August 1944 had been somewhat offset by the addition of a ground-attack squadron (102/1) of Hungarian AF Fw 190s three months later. Schlacht pilots who had once roamed far and wide over open steppe now stalked Soviet tanks in the streets and squares of their own ruined cities – said a member of SG 4 to his wingman during one bomb-carrying sortie over Breslau: "Do you remember the Café Hutmacher in the Schweidnitzerstrasse? I think I wiped it out this morning."

The training structure was also on the verge of complete collapse from want of fuel and the lack of safe airspace over a contracting Reich. Most of the personnel and trainees from the four Schlacht flying schools (SGs 101-104) were remustered into *ad hoc* infantry units and thrown into the final desperate battle for Berlin. So were those who had managed to complete what had passed for a training programme and had since moved to the two replacement Geschwadern – SGs 111 (Nachtschlacht) and 151 – where they were awaiting postings to front-line units already filled to overflowing with unemployed pilots and grounded aircraft.

Although some did manage to keep flying, they found the skies over Germany in the spring of 1945 had no respect for pilots, however experienced. In the closing months of the war a savage toll was taken of veteran unit leaders – four Geschwaderkommodore, eight Gruppenkommandeure and numerous Staffelkapitäne. Hauptmann Rudolf Smola, for

The most potent tank-killer of them all was the Hs 129B-3/Wa, which carried the huge BK 7.5 cannon. Note that the lower fuselage guns (MG 17s) were removed.

example, the Kommandeur of I./SG 3, was brought down by small-arms fire over East Prussia on 27 March; Crimean ace Oberleutnant August Lambert, Staffelkapitän of 8./SG 77, who had a personal score of 116 – the highest number of aerial victories of any Schlacht pilot – was bounced on 17 April by 60-80 P-51s when at the point of take-off while leading nine Fw 190s of 7. and 8.Staffeln to bomb a Soviet airfield, and was killed northeast of Dresden together with six of his fellow pilots; Major Bernhard Hamester, acting Kommodore of SG 3, crashed in flames while attacking Stalin tanks south of Berlin five days later; Hauptmann Andreas Kuffner, of the recently activated I.(Pz)/SG 9, was shot down by Spitfires while attempting to land at Sülte, east of Hamburg, after a mission on 30 April which had already cost him two of his Staffelkapitäne. And so the list goes on.

Escape to the West

For the survivors, the only decisions remaining were when, how and to whom to surrender. Trapped in the Courland pocket, III./SG 3 did not receive permission to fly out until the very last day. Most pilots then followed orders, heading west for Schleswig-Holstein and British captivity (some taking as many as four of their ground crew members with them, squeezed into the cockpit and rear fuselage of their 190s). Others opted to make for the safe haven of neutral Sweden. The remnants of Major Peter Gassmann's SG 1, who had been attacking the Oder bridges in a fruitless attempt to halt the Red Army's advance on Berlin, also managed to evade the encircling Russians; taking off from Gatow, they headed for Schleswig. To their north, the operational Staffeln of SG 151 in Denmark simply stayed put.

In the southern part of a Germany now split in two by the Russian and American link-up on the Elbe, in Austria and in Czechoslovakia – the areas where the bulk of the Schlachtgruppen were situated – it was a similar story. Nearly all tried to escape westwards to the American lines. Hans-Ulrich Rudel, by then Kommodore of SG 2, flew in to Kitzingen with some of his pilots and formally surrendered to US forces. Other aircraft headed instead for Munich-Riem. The Geschwader's ground personnel, following by road, did not all make it; they were overrun by Soviet tanks northwest of Prague. SG 4 was disbanded in Upper Silesia and northern Czechoslovakia. At Zeltweg in Austria – where their last delivery of fuel became a line of blazing tank-wagons in the nearby railway sidings, the result of attack by US bombers – members of IV.(Pz)/SG 9 blew up their Hs 129s. Zeltweg was also the end of the line for elements of SG 10, the rest being disbanded at Budweis and Prerau in Czechoslovakia.

SG 77 was also in Czechoslovakia. On the last day of the war, 8 May 1945, while most were intent on seeking sanctuary with the Western Allies, the Kommandeur of III./SG 77 at Pardubitz, Hauptmann Gerhard Stüdemann, ordered the fuel drained from all but four of his Gruppe's aircraft. Fully tanked-up, these four – led by Hauptmann Günther Lüdigkeit, Kapitän of 7.Staffel – were then instructed to take off and set course westwards for the capital Prague, bomb the city's radio station, which was in the hands of Czech militants, and return to base. Flying perhaps the last Schlachtflieger mission of the war, the four pilots carried out their orders to the letter. Tipping on to his port wing, Lüdigkeit dived on the radio station, the others following in his wake. They released their bombs at a height of 1500 m and then – ignoring the reports of US armoured spearheads sighted less than 15 km (9 miles) away from the Czech capital – resolutely turned back eastwards to fly more than double that distance back to Pardubitz … and Soviet captivity. **John Weal**

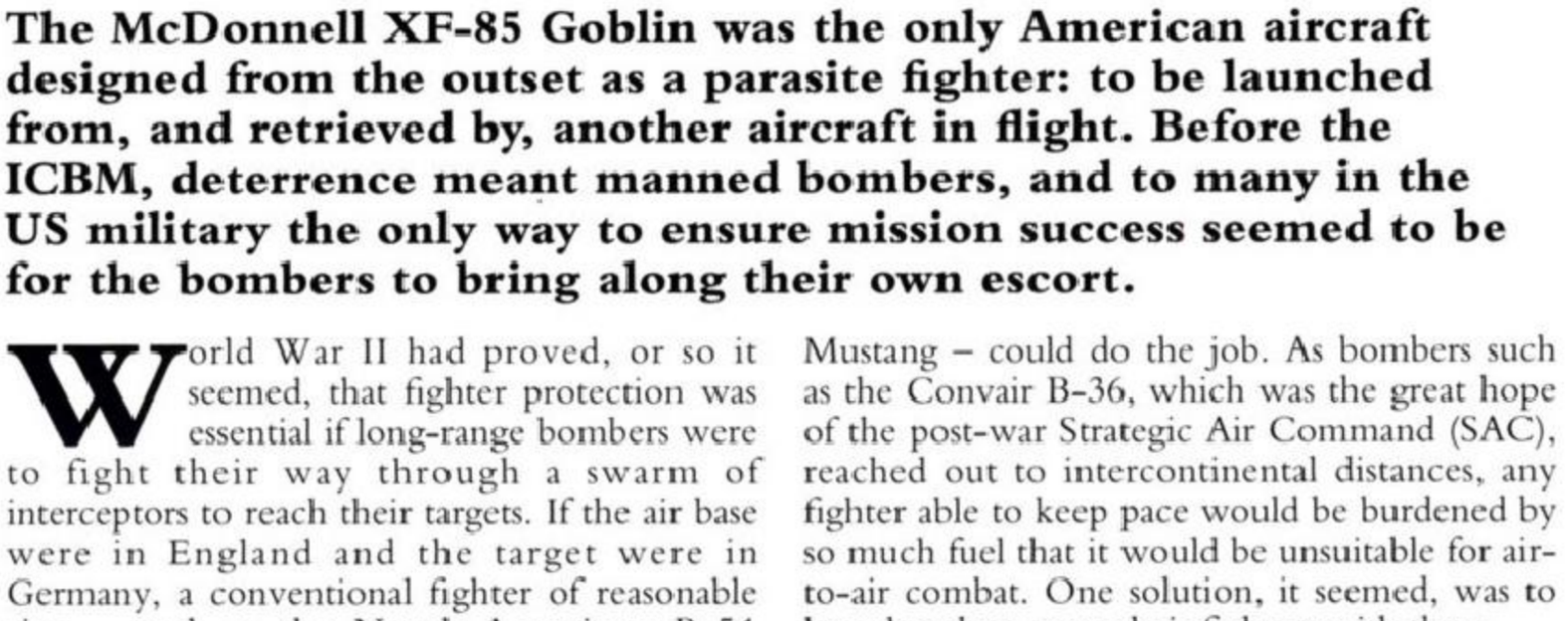
Fw 190s awaiting repair litter the Berlin-Tempelhof apron in 1945. Most serviceable machines had been flown north to Schleswig-Holstein and British captivity.

McDonnell XF-85

The Built-in Fighter

The McDonnell XF-85 Goblin was the only American aircraft designed from the outset as a parasite fighter: to be launched from, and retrieved by, another aircraft in flight. Before the ICBM, deterrence meant manned bombers, and to many in the US military the only way to ensure mission success seemed to be for the bombers to bring along their own escort.

World War II had proved, or so it seemed, that fighter protection was essential if long-range bombers were to fight their way through a swarm of interceptors to reach their targets. If the air base were in England and the target were in Germany, a conventional fighter of reasonable size – such as the North American P-51 Mustang – could do the job. As bombers such as the Convair B-36, which was the great hope of the post-war Strategic Air Command (SAC), reached out to intercontinental distances, any fighter able to keep pace would be burdened by so much fuel that it would be unsuitable for air-to-air combat. One solution, it seemed, was to have bombers carry their fighters with them.



The two XF-85s were preceded by a full-scale mock-up, seen here at an air show with a B-36, its intended mother plane. It differed from the prototypes in having only four tail fins, ports for four machine-guns and, for an unknown reason, an opaque central windscreen panel.

Looking back at this flickering instant in aviation history, it seems obvious that the XF-85 was an idea that could not work – a lightweight ship with limited capacity for avionics and armament, plus a confounding 'skyhook' and trapeze arrangement that looked like a creation of the mad cartoonist of that era, Rube Goldberg. Even at the time, SAC leaders questioned the value of the XF-85 because of its limited endurance. A summary of what the Goblin actually achieved would be brief: the aircraft flew seven times over a period of eight weeks, logged two and one-half hours of flight time, made three successful hook-ups, and terminated four flights in belly landings on the dry lake bed at Muroc, California. Only one man ever sat in its cockpit. When the programme was cancelled in April 1949 due to difficulties in achieving air-to-air rendezvous with the XF-85's skyhook, little had been accomplished with this unique aircraft.

Prior to the arrival of the XF-85 in the post-war jet era, there had been few attempts to develop parasite fighters. No fighter had been designed explicitly for this purpose. The US Navy's Curtiss F9C-2 Sparrowhawk, developed from an intended carrier-based light fighter, had been stored aboard, and had flown to and from, the dirigibles USS *Akron* (ZRS-4) and USS *Macon* (ZRS-5). In another experiment to extend fighter range, a Grumman F4F Wildcat fighter was towed for more than 1,000 miles

(1610 km) behind a Boeing B-17 Flying Fortress equipped with a flexible cable. The mother ship was to be the B-36, development of which had started with a US Army Air Forces (USAAF) contract of 11 April 1941.

In December 1942, the USAAF launched Project MX-472 to explore solutions to the problem of giving fighter escort to bombers spanning intercontinental missions. No solution was obvious. Air-to-air refuelling was not yet in use. Pilot fatigue was a problem that defied solution when contemplating a mission that might cover 10,000 miles (16100 km) and take up to 30 hours. An early concept was to provide escort with remotely controlled drones powered by ramjet engines, but by the autumn of 1944 the USAAF favoured a manned fighter capable of being stowed aboard the bomber.

New manufacturer

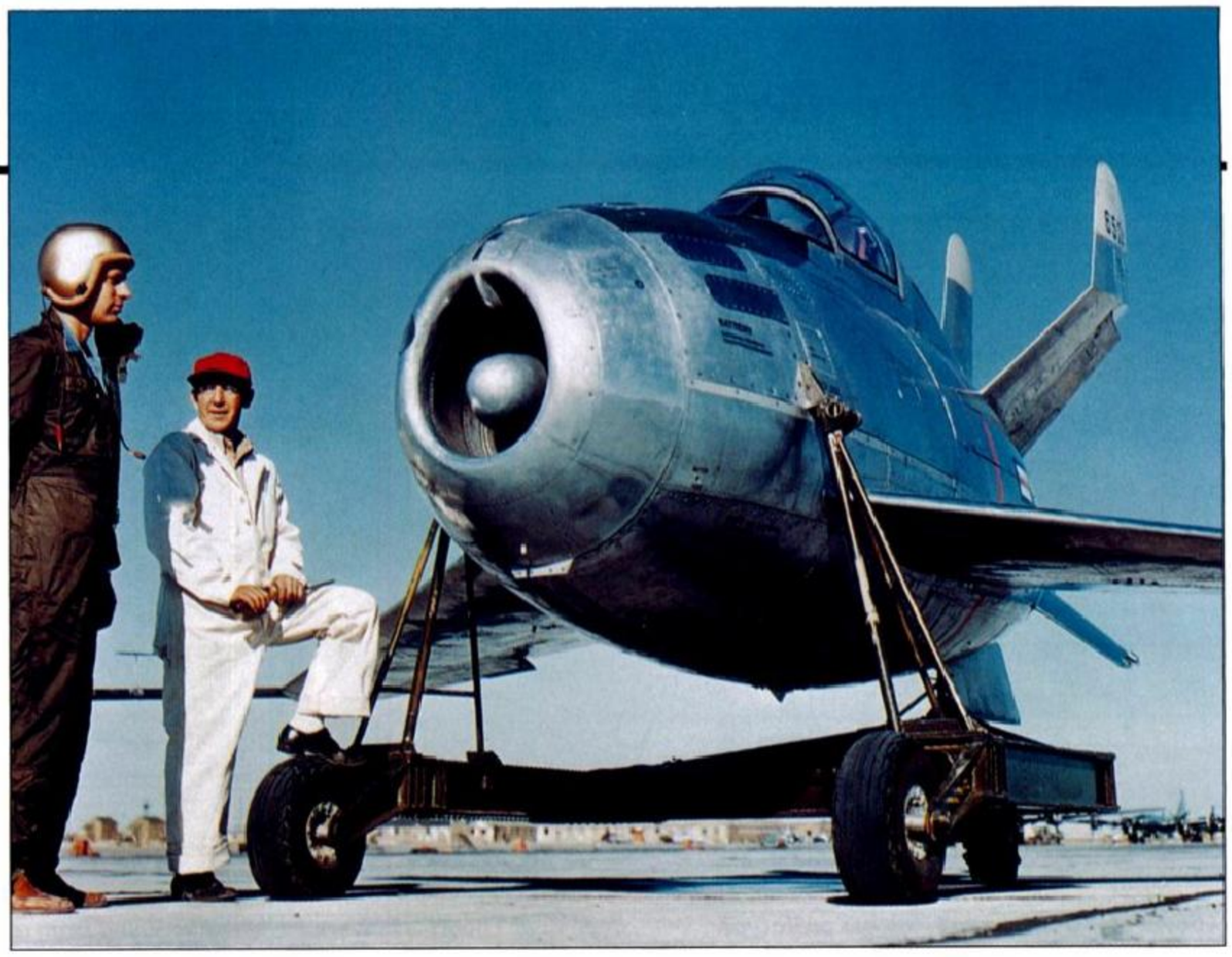
Unfortunately, the Army could not find a company that wanted to invest effort and risk in a parasite fighter. In St Louis, Missouri, the large aircraft manufacturer Curtiss-Wright had built thousands of C-46 Commandos and A-25 Helldivers, and had developed a huge, twin-engined fighter, the XP-71. A young designer at Curtiss, who had a key role in all of these aircraft, was Herman D. Barkey, who remembers that Curtiss turned its thumbs down when the Army came looking for a parasite builder. "They just didn't need the aggravation," Barkey said.

Far less known in St Louis was the obscure aircraft company founded by James S. McDonnell. To the handful of people who worked for him, he was known as 'Mr Mac' or 'the old man', even when far from elderly. His company became known as MAC (later McAir). Friends who addressed him by his first name – "of whom there were none," Barkey remembered wryly – called him J. S.

The McDonnell Aircraft Company manufacturing the Fairchild AT-21 Gunner twin-engined trainer under licence. McDonnell also developed a twin-engined fighter, the XP-67, that had burned to oblivion on the ground after an inflight fire. There was little to commend this new builder as the likely firm to build the parasite fighter, or anything else. Chief designer Garrett 'Gary' Covington had come from the Naval Aircraft Factory in Philadelphia early enough to be granted employee clock number 3 (clock number 1 went to 'Mr Mac' and number 2 to his secretary). Covington may or may not have had experience with the Navy's Curtiss F9C-2 Sparrowhawk – the extent of his experience is in dispute – but he clearly saw the conventional jet fighter as the wave of the future.

So did J. S. McDonnell, who negotiated a deal with the Army. He would build the parasite fighter – something no other manufacturer was willing to undertake – if the service would also give him a contract for a conventional jet fighter. After much haggling, the service agreed. In 1944, McDonnell submitted four versions of its Model 27 to the USAAF. No other American company was interested.

Shortly thereafter, McDonnell went to Curtiss-Wright and hired away the promising young Barkey, who came on board only in time to receive employee clock no. 14,087.



Pilot Ed Schoch and a McDonnell engineer pose with a Goblin at Muroc prior to the type's first flight in the summer of 1948. Schoch is wearing the helmet which was to be knocked from his head during the Goblin's first free flight.

Barkey was, and to a degree still is, almost unknown among aircraft designers, yet he headed design teams that created not only the XP-85 but the F2H Banshee, F3H Demon, F-101 Voodoo, and F4H Phantom II. Barkey also did the design work on the conventional fighter that McDonnell was given as a *quid pro quo* – the P-88. Although its history is beyond the scope of this narrative, that aircraft became the XF-88 and performed well in all tests. The Air Force (which separated from the Army on 18 September 1947 to become an independent service branch) did not honour its word and, even after the aircraft won a fly-off competition, did not buy the F-88. Had it done so, there would have been F-88s available to confront the MiG-15 in Korea – but that is another story.

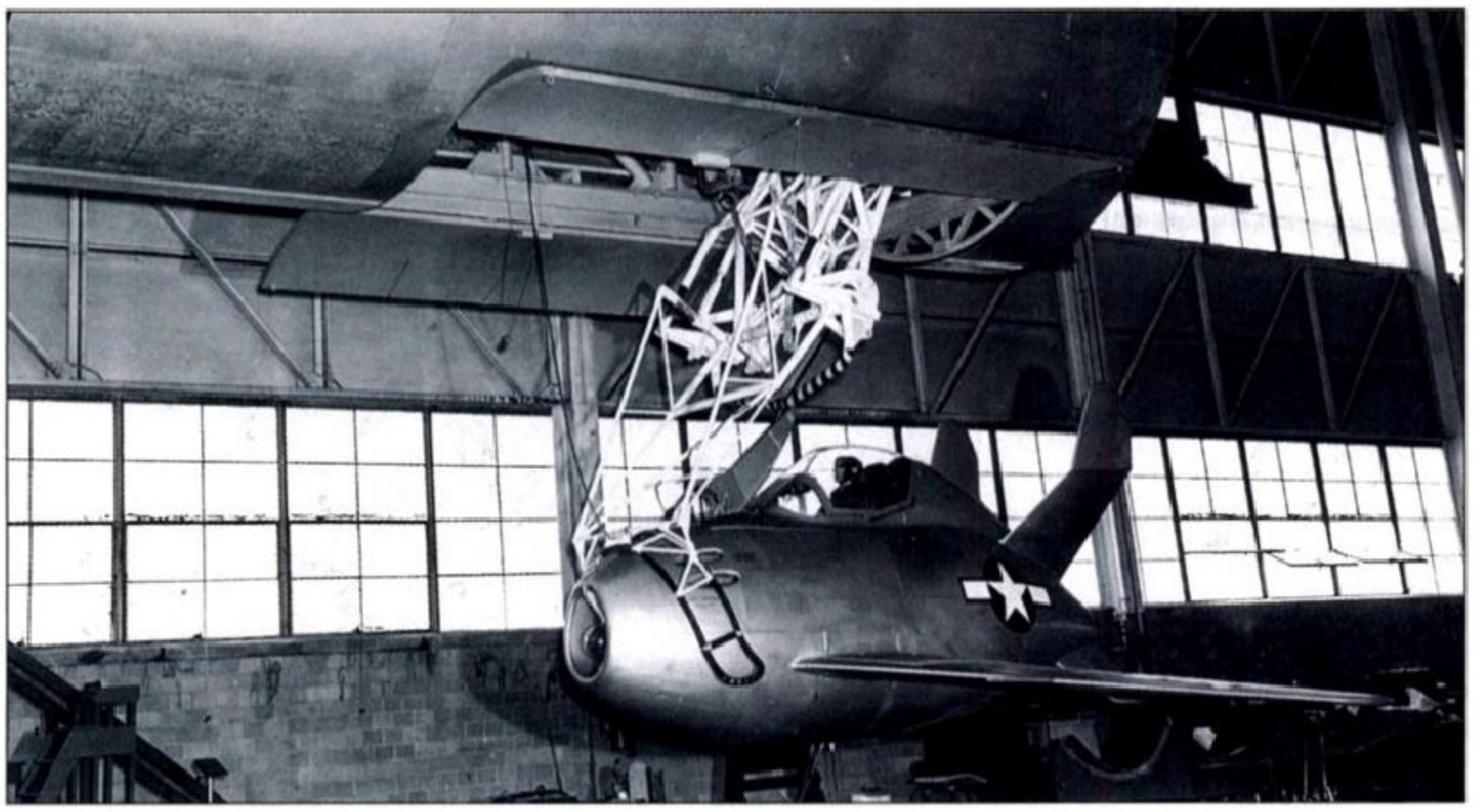
Parasite fighter

The USAAF initially planned to use the parasite fighter with the Boeing B-29 Superfortress and Northrop B-35 flying wing bombers, as well as with the B-36. By January 1945, the service decided to develop a fighter that could be fully retracted, precluding its use with the B-29. On 9 October 1945, the USAAF contracted with the manufacturer for the McDonnell Model 27E, designated XP-85. This was a short, chunky fighter with low-mounted, folding, swept wings, and an X-shaped tail. Dimensions of the fighter were dictated by the size of the B-36 bomb bay segment (bay number one or four), namely 15 ft by 5 ft 6 in (4.57 by 1.70 m).

Confronted with these dimensions, McDonnell's chief engineer Covington and project engineer Barkey 'pinched and squeezed' to make the XP-85 fit. In retrospect, it is clear that Covington's role was minimal. The XP-85, or McDonnell Model 27E, had begun on the drawing board as a conventional aircraft and was transformed into a narrow, bulky, egg-shaped craft that could be contained by a B-36 bomb bay.

Prospects for the parasite fighter seemed bright in early 1947. The Air Force directed Convair to modify all B-36s, from the 23rd production example onward, for a trapeze in the forward bomb bay. Plans existed to procure 30 P-85s to form at least a full fighter group. Only one P-85 would normally be carried, but the big bomber could accommodate a maximum of three and it was contemplated that some B-36s might be modified into P-85 'carriers'. The Army ordered only two prototypes (46-523/524), however, and in August 1947 the service postponed further

The first XF-85 (46-253) was sent to the NACA Ames Laboratory at Moffett Field in January 1948 where it was accidentally dropped while being hoisted into place in the wind tunnel. While repairs were underway (and for the majority of the test programme) its place was taken by the second Goblin, 46-254. Note the ventral 'cheese grater' airbrake.



Above: The Goblin mock-up and prototype trapeze were tested by McDonnell under a dummy wood-and-metal-clad B-36 bomb bay section. The dimensions of the XF-85 were dictated by the size of this cavity, although the Goblin would never get to fly from a B-36.

Below: The XF-85s were frequently moved from factory to laboratory to airfield by air, a process that required some disassembly even for the diminutive Goblin. In this case, however, it is the mock-up that is seen leaving St Louis by C-82 in January 1949.

production and cemented its decision to stay with the two test articles.

The McDonnell XP-85 Goblin had low- to mid-set foldable swept wings of 21 ft 1.25 in (6.44 m) span, a short rotund fuselage that made it resemble a 'bloated bug' (in the words of one McDonnell employee), no landing gear except for emergency skids, a retractable hook (sky-hook) to engage a trapeze on the parent aircraft, and six tail surfaces clustered around the rear of the aircraft. The Goblin had no landing gear, so a wheeled dolly was used for ground handling and loading. Power was provided by a 3,000-lb (13.35-kN) thrust Westinghouse J34-WE-22 turbojet mounted to the rear fuselage. The XP-85 had a perforated, 'cheese grater' speed brake which extended below the lower rear fuselage; it was one of the first such speed brakes on a jet fighter.

The use of wing sweep on the XP-85 Goblin was remarkable, since it predated the availability of German engineering data and North American's redesign of the straight-wing XP-86 into the swept-wing Sabre. Not that the Goblin was the first American fighter with swept flying surfaces; Northrop's XP-56 piston-engined fighter, first flown on 6 September 1943, had swept wings.

The jet engine was positioned as far forward in the fuselage as possible, to maximise the distance between the Goblin's centre of gravity and its tail surfaces. A 52-in (132-cm) tailpipe extension carried the jet exhaust beyond the fuselage, with a special insulating blanket wrapped around to reduce heat transfer to the adjacent structure. Additional cooling was accomplished by diverting air from the intake duct around the engine and tail pipe.

Ideally, the skyhook would have been at the Goblin's centre of gravity, with the little fighter balanced much like an upside-down seesaw. In extended position, the XP-85's attachment point actually was 2-7 in (12-17 cm) ahead of the centre of gravity and about 60 in (152 cm) above it. The Goblin was intended to achieve release from the bomber by tumbling the sky-hook head. A safety switch prevented release while the Goblin's wings were folded.

Tight quarters

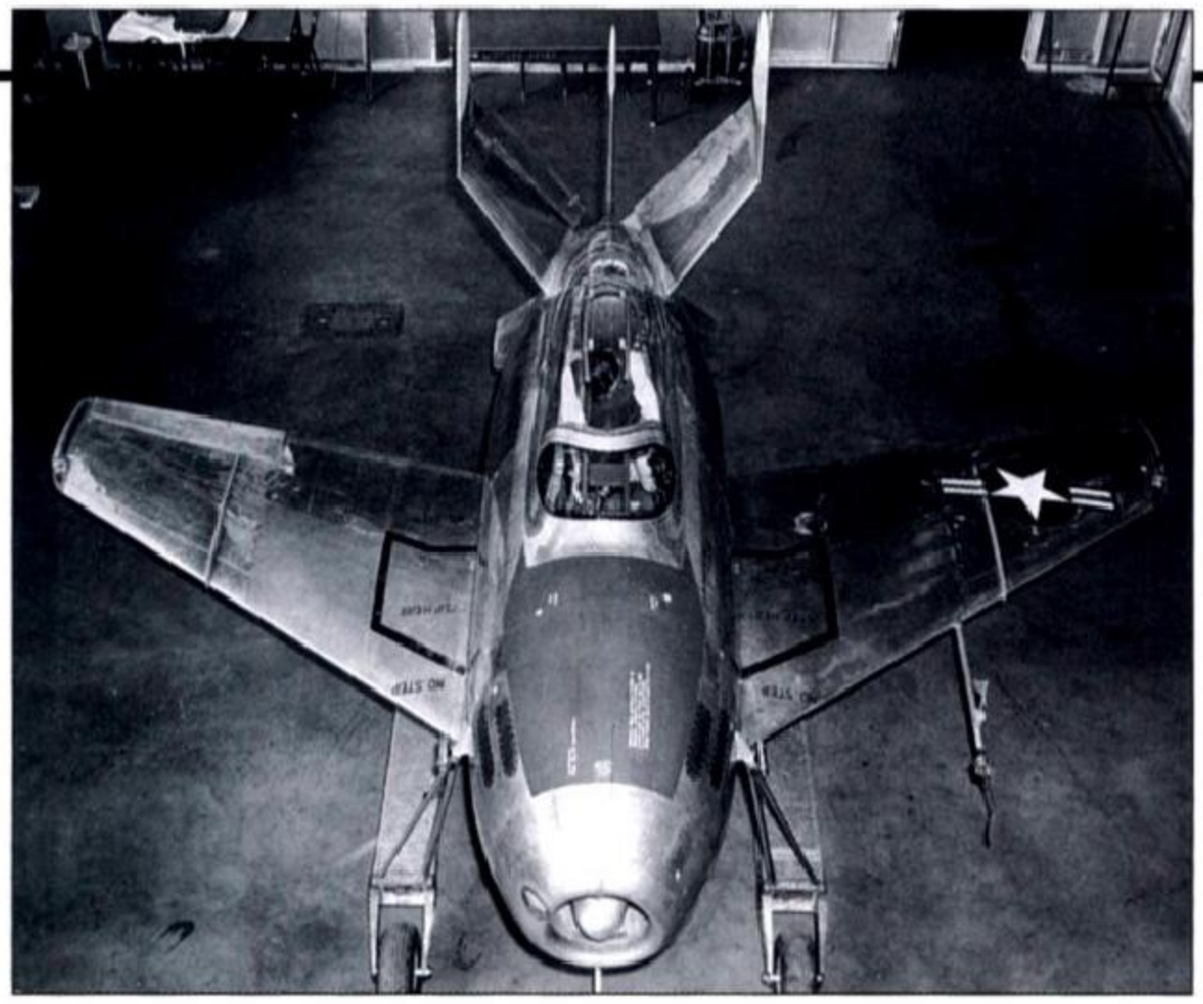
The XP-85 had a confining 26-cu ft (0.73-m³) cockpit. The escape system consisted of a T-4E powder charge fitted to the pilot's seat. Because the pilot sat astride the engine, the seat was canted back 33° to reduce the frontal aerodynamic drag of the aircraft. The cockpit was spartan, to put it generously. Like an astronaut in space, the Goblin flier would get no amenity that was not justified. Thus, the rudder pedals were adjustable but the seat was not. The XP-85 canopy had a small, low, one-piece windscreen and a Plexiglass cover that folded to the left side of the aircraft when in the open position, meaning that the Goblin was entered only from its right.

The Air Force intended to arm the XP-85 with four 0.50-in Browning M3 machine-guns with 300 rounds of ammunition per gun. As a measure of how effective the F-85 might have been in combat, early F-86 Sabres were deemed inadequate against the MiG-15 with six identical guns and 267 rounds per gun. On the Goblin, where space and weight were precious, the ammunition was to be stored in a compartment just behind the cockpit and the empty cartridges and links ejected into an empty bay in the fuselage.

Mother ship

McDonnell was putting the finishing touches on the first XP-85 (46-523) and modifying a Boeing EB-29B Superfortress bomber from among a batch manufactured by Bell Aircraft in Atlanta (44-84111), nicknamed *Monstro* and fitted with a trapeze. The 'E' prefix (meaning 'exempt – no other prefix applicable') signified

The second Goblin was rolled out ready for transportation to Muroc at the end of May 1948. The retractable sprung-steel landing skids that were then fitted can be seen under the wings. The original pitot tube arrangement (mid-wing and undernose) can also be seen.



Left: This is the view of the XF-85 that would have been seen by the trapeze operator during a hook-up, albeit with the skyhook extended from the nose bay.

Above: After the Ames tests, a number of modifications were made, including the addition of dorsal and ventral vertical tail fins and a film camera beside the intake.

in this case that the B-29 was bailed to McDonnell. No B-36 could be made available for the tests.

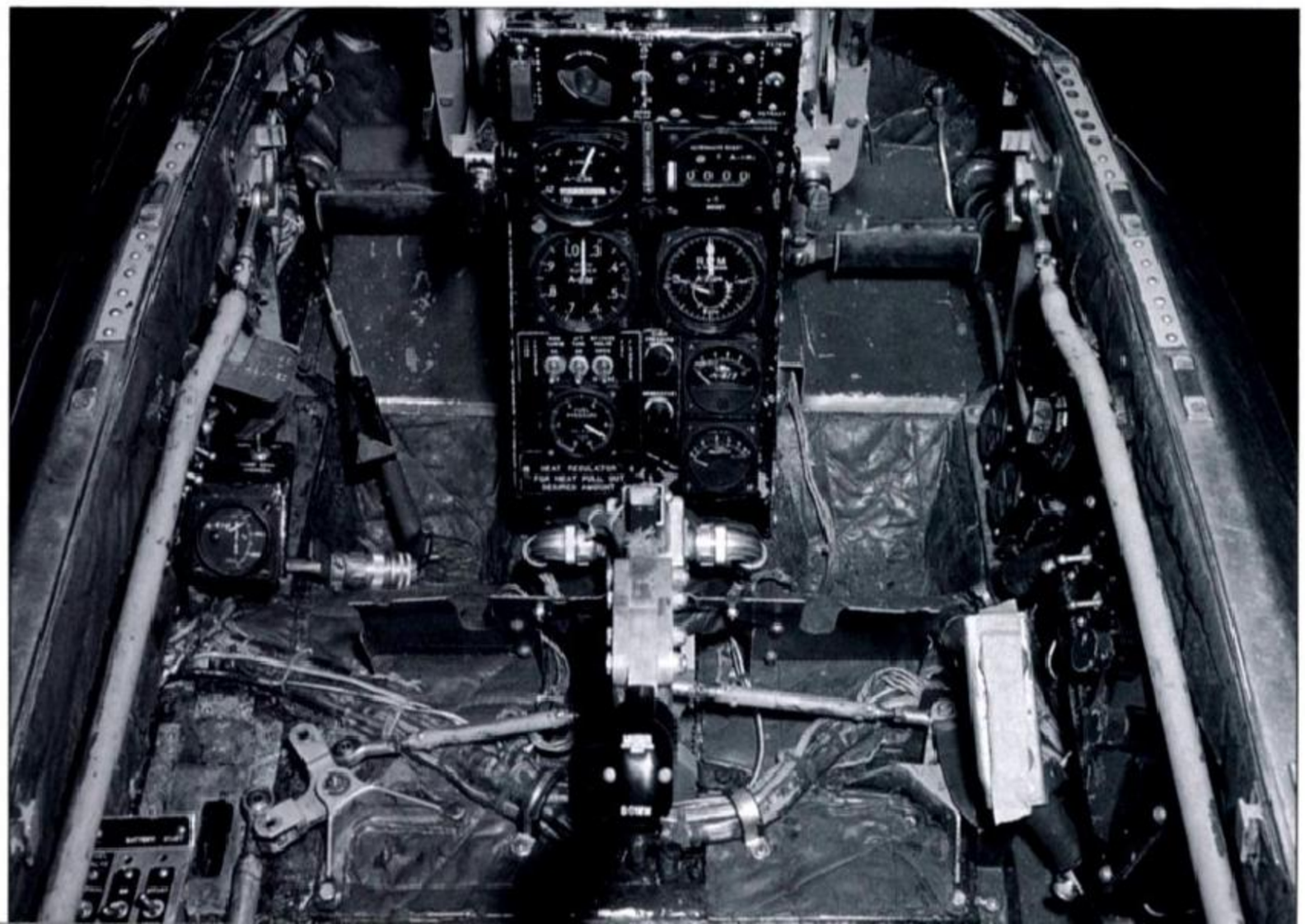
The B-29 was intended to be easily visible. *Monstro*'s rear fuselage and tail were painted bright yellow, and wingtips and horizontal tail surfaces (but not ailerons or elevators) were painted with large diagonal yellow and black stripes. Consideration was given to using smoke bombs or skywriting equipment to make the bomber more visible to the Goblin pilot. The whole subject of hooking and unhooking the Goblin was examined repeatedly.

Airship escort

The only precedent was the US Navy's work with F9C-2 biplane fighters aboard the airships *Akron* and *Macon* in the 1930s. There were differences, obviously, between hooking on a biplane at 70 kt (130 km/h; 80 mph) and hooking on a jet fighter at 200 kt (370 km/h; 230 mph), but McDonnell's engineers studied the *Akron-Macon* data and their trapeze design was remarkably similar to that used aboard the airships.

During 10-12 June 1946, representatives from McDonnell, Consolidated Vultee (the B-36 manufacturer) and the Army met in St Louis to examine a mock-up of the XP-85/B-36 combination. As planned for the operational B-36, the installation was to include heating for the no. 1 bomb bay, storage for 2,400 rounds of ammunition (a full load for two sorties), refuelling equipment (the XP-85 was to draw its fuel from the bomber's tanks) and the trapeze and associated equipment. The Army approved the B-36 arrangements which, it was anticipated, would increase the bomber's weight by 2,200 lb (1000 kg). One member of the mock-up board, Major Ken Chilstrom, considered the XP-85 to be "very much of an oddity" and felt there was "limited interest" in it.

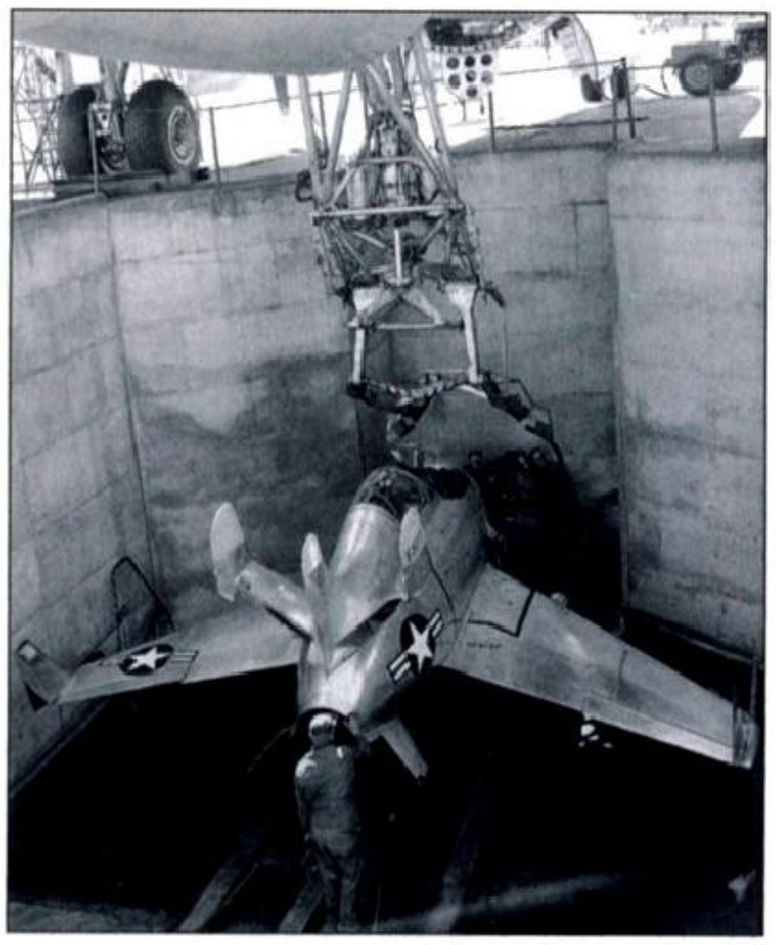
In the summer of 1947, while engineering work on the XP-85 progressed, the first flying connected with the programme took place. On 22 July 1947, Chilstrom and McDonnell test pilot Robert Edholm flew Lockheed P-80s in simulated hook-up approaches to a B-29 near Wright Field, Ohio. The pilots flew the P-80s with dive brakes extended and 40 per cent flap. Chilstrom recalls that there was "no problem at



Above and below: The Goblin's tiny cockpit was hardly well-equipped for a jet fighter, even by the standards of the day. The 'instrument panel' was in fact the rear face of the skyhook well and sported most, but not all, of the dozen instruments fitted. Chief among the differences that can be seen in these views of 46-253 (above) and – probably – 46-254 (below) is the absence of some instruments from the main panel and the presence of others, including a conventional airspeed indicator. The unusual throttle lever with its speedbrake button is visible on 46-253 but not in the lower photo.

Goblin and pilot pose with the EB-29B* Monstro *at Muroc in April 1949, near the end of the test programme. The Goblin is 46-253 in its final configuration. At right is the loading pit.

The B-29 was backed over the loading pit and the trapeze extended. The Goblin was winched into the loading pit and the 'horse collar' fitted. This is 46-253 on 14 March or 8 April 1949.



all", but no-one fully understood that the XP-85 would perform quite differently.

Before the flight programme even began, the first XP-85 seemed to be plagued by a jinx. In the autumn of 1947 it was put aboard a Boeing C-97 and flown to the National Advisory Committee for Aeronautics' Ames Aeronautical Laboratory at Moffett Field, California, for full-scale wind tunnel tests. At Ames it was accidentally dropped from a crane from a height of 40 ft (12.19 m) and had to be airlifted back to St Louis via C-97 for repairs.

The second ship (45-524) travelled to Ames aboard a Fairchild C-82 Packet for NACA wind-tunnel tests and thereafter returned to St Louis the same way. Both Goblins logged more time in the air as cargo than under their own power.

The USAAF (which became the Air Force on 17 September 1947) was considering other ways to extend the range of fighters. At Wright Field the service tested an arrangement under which a bomber and fighter would rendezvous, the fighter would attach itself to a cable, and the bomber would then tow the fighter over a prolonged distance – a latter-day version of the earlier towing experiments of World War II. The idea fell apart on 23 September 1947 when a P-80A (44-84995) flown by Lieutenant Colonel Pat Fleming encountered difficulty disengaging from a B-29 (42-93921) flown by Major Guy Townsend.

Fleming attempted to release the tow cable but his hook would not open. After trying other solutions, Fleming pulled closely into and under the B-29 where he encountered violent turbulence that broke the P-80's sheet metal nose attachment for the hook, which released the cable from the hook. The shower of metal parts and debris damaged the P-80 and the B-29, both of which landed safely only after great exertion by the skilled pilots. Towing experiments were suspended for a time, and were revived after the competing XP-85 Goblin was history.

The second XP-85 was flown from St Louis to Muroc on 5 June 1948 aboard a C-97. By mid-June 1948 the modified B-29 and the XP-85 were ready for tests. On 22 July 1948, 11 days after its designation changed from 'P' for pursuit to 'F' for fighter, the XF-85 made the first of five captive flights prior to flying under its own power. The test programme included six subsequent captive flights.

Edwin Schoch, the XF-85 test pilot, had been trained as a naval aviator. Flying a Grumman F6F Hellcat from USS *Lexington* (CV-3) in the Pacific he had shot down four Japanese aircraft. As a pilot on McDonnell's engineering staff, he had an important role in flight test work on the US Navy's XFD-1 (later FH-1) Phantom and F2H Banshee carrier-based fighters; in fact, Schoch lost his life in an F2H-3 Banshee in September 1951. He was the only pilot to fly the XF-85 .

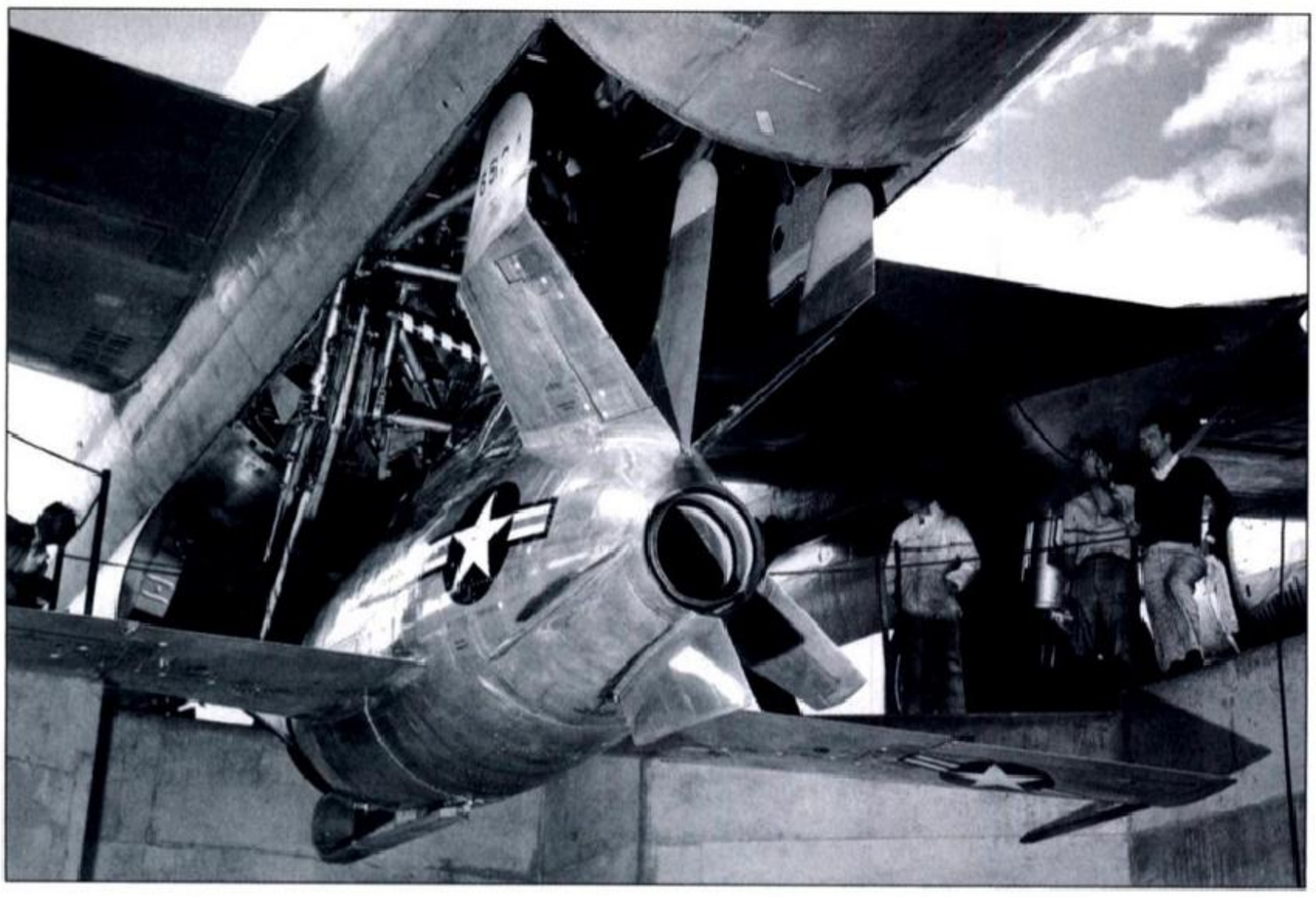
Trapeze artist

During the captive flights, with Ed Schoch strapped in, trapeze operator Lester Eash lowered the XF-85 into the airstream and raised it. Schoch ran the engine and tested flight controls by 'flying' the XF-85 from the sky-hook. Eash, located in the aft pressurised compartment between the gunners' blisters, probably had the more difficult job.

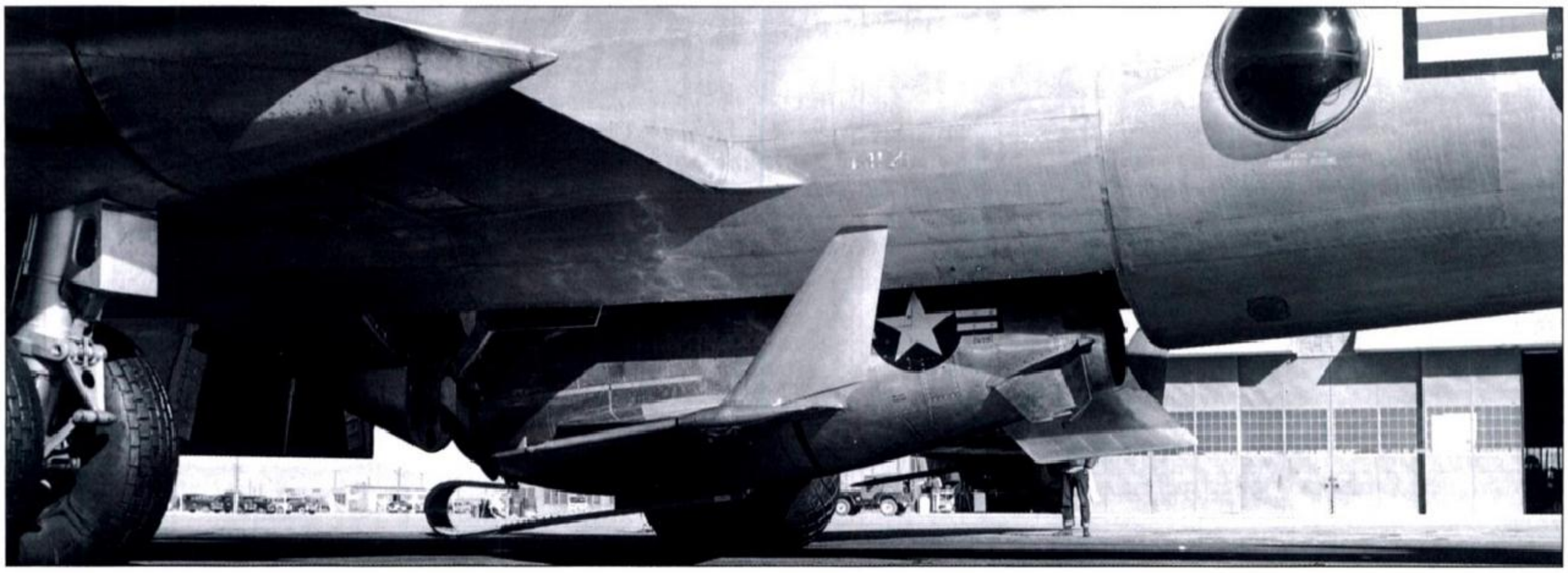
As reported in research by Richard D. Powers, Eash later remembered:

"With the XF-85 on the arresting bar and the horse collar raised, the pilot started the engine and made repeated lift-offs within the confines of the hook diameter. The airplane was in control, moving laterally on the bar and pitching up and down. Subsequently, the airplane appeared to go divergent and Ed called for lowering the horse collar in an attempt to catch the oscillating nose. On the first attempt I punctured the nose cowling and oil tank, the second missed completely, and on the third attempt I luckily caught the nose as it was moving in a lateral direction. After getting back to the ground, all I could say was, 'It was a helluva J.C.' [difficult manoeuvre]."

By August, the Goblin was ready for free flight. Instruments and a recording camera were installed in the empty ammunition bay in the fuselage behind the cockpit. On the morning of 23 August 1948, the B-29 taxied astride a special pit for loading the parasite. Ground crewmen rolled the XF-85 into the pit on a



The reasoning behind the Goblin's 'bent' upper fins can be understood in this view of 46-524 being eased into* Monstro*'s bomb bay, the dimensions of which also dictated the aircraft's length. The loading pit was built specifically for the XF-85 programme and had little spare room.



A temporary undercarriage was originally proposed for the test programme, but in the end sprung-steel skids were used instead. The mid-wing skids were later removed, but the prominent central skid was retained and can be seen in this view of a late-configured Goblin tucked into the belly of the EB-29B.

Right: This view of engineers working on 46-524 at Muroc clearly shows the skyhook mechanism. Problems with turbulence around the base of this unit and its well resulted in various temporary fixes before an effective fairing was designed and fitted. Note that the data block at this time read 'XP-85'.

dolly. The skyhook was mated to the extended trapeze, which hoisted the XF-85 into the bomb bay. McDonnell pilot Arthur Courtial took the B-29 aloft while Schoch rode in the aft compartment of the bomber. When the B-29 was at the testing altitude of 20,000 ft (6096 m), Courtial passed word back to the gunners' compartment where a McDonnell field engineer tapped Schoch on the shoulder and pointed at the door to the bomb bay.

The Goblin flies free

Eash lowered the trapeze, extending the XF-85 into the rush of air around the bomber. Schoch started the engine and brought it up to 11,000 rpm. He eased back on the stick to bring the nose up about 8° and gently lifted the XF-85 off the trapeze. As soon as the skyhook was away from the yoke of the trapeze, Schoch began flying the XF-85 Goblin for the first time.

Schoch put the egg-shaped little fighter through a series of manoeuvres at 180 to 250 mph (290 to 400 km/h). The pilot felt that the XF-85 demanded too much back-stick pressure from him but that otherwise flying characteristics were excellent. The Goblin's first flight seemed close to success when Schoch flew back to reattach the fighter to the B-29. But, then, the pilot found himself in a sudden crisis – bucked by turbulence and unable to attach.

It is difficult to imagine how Ed Schoch could have been better prepared for the job. He had spent several hours in a Lockheed P-80 Shooting Star flying close to the B-29's underside and making simulated trapeze approaches. As he approached the B-29 there was an increasing cushioning effect as the air flowing off the large aircraft became compressed between it and the fighter. Schoch needed to apply constant but gentle increase in throttle to overcome this resistance. Moreover, the closer he flew to the B-29 the more turbulent the air became.

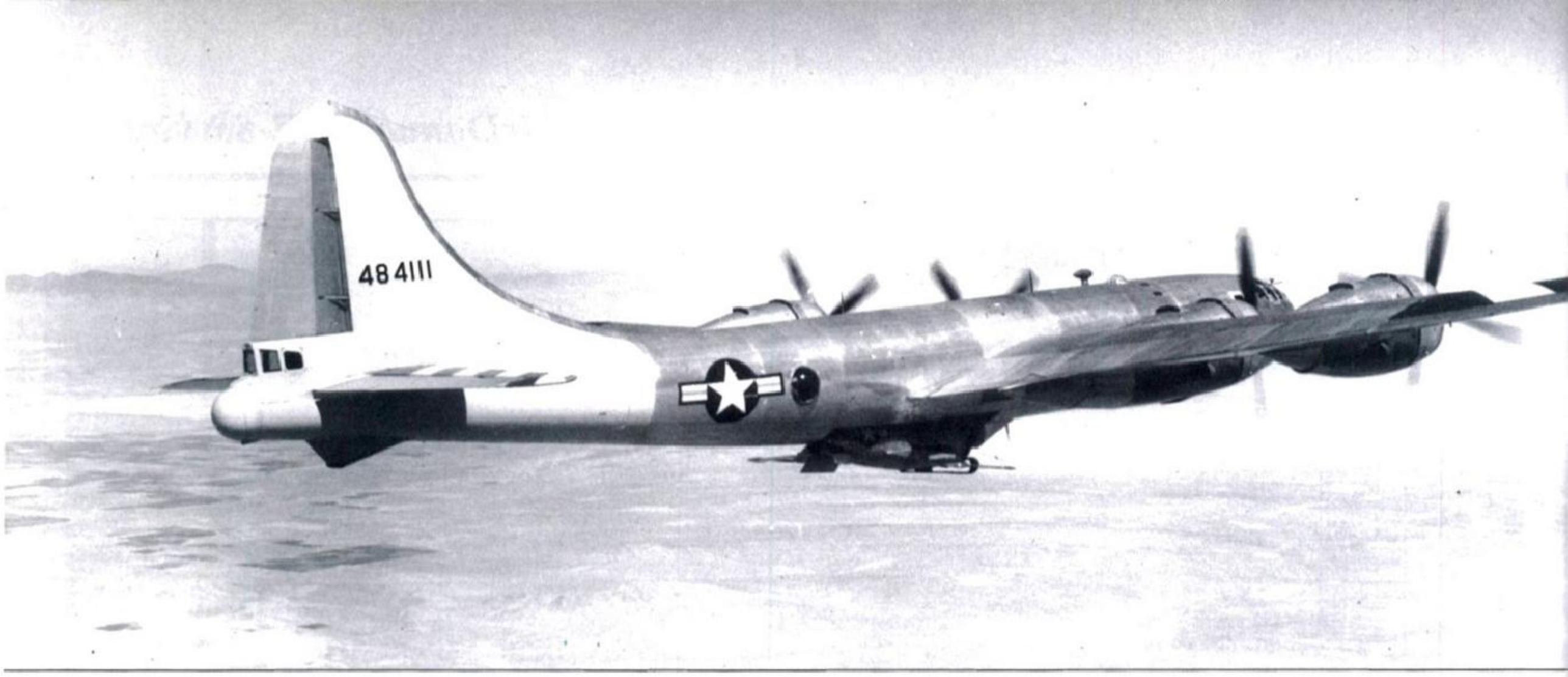
Eash's recollection is that the Shooting Star was a 'stock' P-80 with a wand "like a radio antenna on a car" that equalled the height of the Goblin's skyhook. Possibly, more than one P-80 was used since the modification was minimal. What no-one seemed to appreciate was that the P-80 was longer coupled than the Goblin – i.e., the distance from the centre of gravity to the tail was about 75 per cent greater – so the Shooting Star was more easily able to withstand the turbulence. Attempts to touch the wand (simulated skyhook) of the P-80 to the trapeze on the B-29 worked.

Crisis aloft

Now, flying the XF-85, Schoch ran into troubles for which the P-80 flights had only partly prepared him. When he had the XF-85 about 10 ft (3 m) below the trapeze, turbulence made control very difficult. He lunged at the trapeze with his skyhook and missed – once, twice, three times. Schoch did not know it then, but an optical illusion made the trapeze yoke appear closer than it was. Wracked by tension, Schoch dived away and circled around for a new approach.

Schoch circled and came in to try again. He nudged his way in below and behind the trapeze, but his rate of closure was too fast. The Skyhook missed the trapeze by 3 in (7.6 cm).

Edwin Foresman Schoch was the one and only Goblin pilot. A four-victory Hellcat pilot in the Navy, Schoch flew many of the early McDonnell aircraft and was to lose his life in the crash of an F2H Banshee in 1951. The Goblin's diminutive size ("only 1.5 in longer than a Volkswagen sedan") required a pilot 5 ft 9 in (1.75 m) or shorter.



After five captive tests, during which the Goblin had been lowered on the trapeze and the engine had been run, the day came for the first actual hook-up and recovery, 23 August 1948. This sequence shows (anti-clockwise from above): the Goblin in stowed position beneath the EB-29; 'flying' on the trapeze before release; beginning its return to the docking position (no pictures appear to have survived of the Goblin flying by itself); approaching the underneath of the bomber in clear air; nearing the trapeze in an area of strong turbulence; lunging for the horse collar; and striking the trapeze with enough force to smash the canopy and carry away the pilot's oxygen mask and helmet (just visible). The inevitable skid-landing on the desert floor that followed was one of four that Ed Schoch had to make in the course of the test programme. Despite these misadventures, Schoch was enthusiastic about the flying qualities of the XF-85 and praised its manoeuvrability. How it would have fared against the better-armed and equipped fighters it might have faced over the Soviet Union is another question.

Before Schoch could throttle back, the XF-85's canopy struck the trapeze and shattered. Wind rushed into the cockpit at 200 mph (320 km/h) and tore away Schoch's helmet and oxygen mask. Looking down from his astrodome bubble which extended 15 in (38 cm) from the side of the B-29, Eash saw the loose helmet tumbling away and mistakenly believed it was Schoch's head. But, although bareheaded and stunned, Schoch was still flying the Goblin; instinctively, he shoved the stick forward and dived. Schoch and all aboard the B-29 saw no hope of recovering the Goblin aboard the bomber. His life was now at stake, and he attempted to set the fighter down on the dry lake. Engineers had studied equipping the XF-85 with a temporary wheeled landing gear but had determined that an undercarriage would create as much aerodynamic drag as the entire aircraft. So, Barkey's design team had opted for a rugged steel skid on the aircraft's underside and small steel runners to protect its wingtips. Schoch and other flight test staff had spent hours studying German operating data on the Messerschmitt Me 163 Komet rocket fighter, which was similar to the XF-85 and landed on a skid.

Down in the desert

As Schoch closed with the ground the surface of the lake bed became a 190-kt (350-km/h; 218-mph) flow of brownish-yellow stuff rushing under his nose. Touchdown came at 140 kt (260 km/h; 160 mph). Observers in the B-29 lost sight of the XF-85 in a cloud of golden dust streaking across the lake bed. The XF-85 rocked a bit, dragged one wingtip and then the other, and returned to an even keel for

Specification

McDonnell XF-85 Goblin

Dimensions: length including pitot 96.25 in (4.98 m); fuselage length 177.75 in (4.51 m); height 99.21 in (2.52 m); span (wings extended) 128.0 in (3.25 m); span (wings folded) 66.6 in (1.69 m); wing area 100.52 sq ft (9.30 m²)

Weights: empty 3,984 lb (1807 kg); estimated useful load 1,616 lb (733 kg); gross (service) 5,600 lb (2540 kg)

Powerplant: one Westinghouse J34-WE-22 of 3,000 lb (13.35 kN) thrust

Armament (proposed): four 0.50-in (12.7-mm) machine-guns

Performance (estimated): endurance (maximum at 40,000 ft/12190 m) 77 mins; endurance (full power) 36 mins; maximum speed 648 mph (1043 km/h) at sea level, 573 mph (922 km/h) at 40,000 ft (12190 m); ceiling 42,800 ft (13045 m); climb rate (sea level) 12,500 ft (3810 m) per min; climb rate (at 40,000 ft/12190 m) 2,000 ft (610 m) per min

the remainder of the 1,000-ft (305-m) skid.

Banged up but neither bloodied nor bruised, Schoch climbed out of the cockpit. The XF-85 was even less seriously damaged. The high-adrenaline experience of a sudden, emergency landing on the lake bed became all too familiar to Schoch over the next 10 months. Before resuming flight tests, Schoch logged more practice with the F-80 (as it was by then, redesignated from P-80), and two captive-carry flights were made by the B-29/XF-85 combination. Schoch piloted the XF-85 on the second flight on 14 October 1948, for a 20-minute test of directional stability. This time, it took only two tries to get the skyhook onto the trapeze, and Eash hoisted Schoch aboard. The next day, the XF-85 Goblin made free flights numbers three and four from the trapeze without mishap.

On the fifth flight of the aircraft on 22 October 1948, Schoch encountered a new problem. Until then the XF-85 had been flown with its skyhook constantly extended, with the well into which it retracted carefully faired over with tape. Now, the test team removed the fairing and Schoch flew the Goblin with its hook retracted. This improved performance, but when the pilot extended the hook disturbance around the retraction well reduced directional stability to the extent that Schoch could not begin to get his skyhook near the trapeze yoke.

Wobbling Goblin

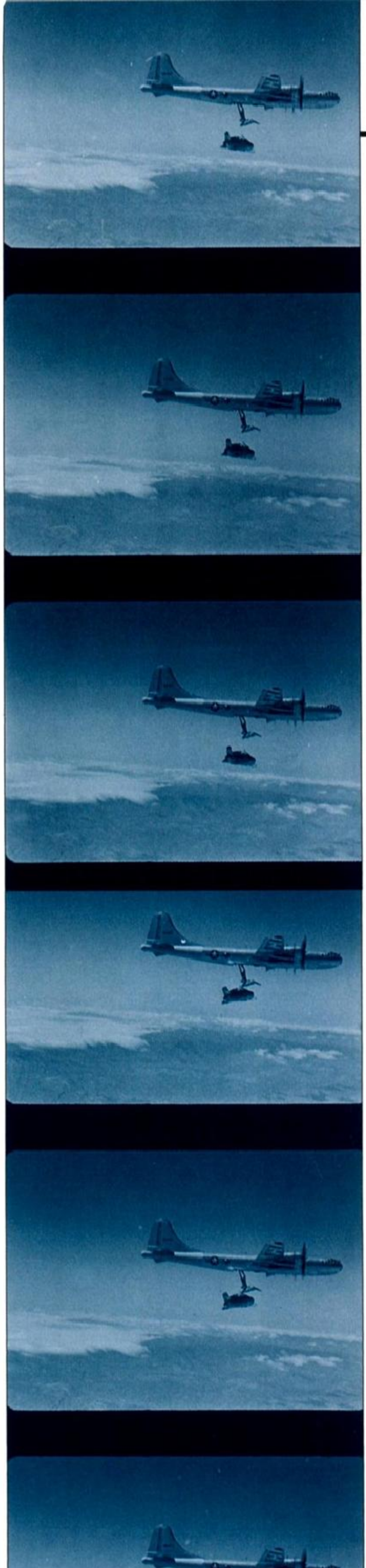
For 10 aggravating minutes Schoch bounced around under the B-29, fighting the XF-85's tendency to slide all over the sky. Finally, he lunged at the trapeze. The XF-85's speed was too great and the impact broke the hook. Unable to hook up with the bomber now, the pilot ended this 36-minute flight in a 1,500-ft (460-m) cloud of yellow dust.

After the unsuccessful first hook-up, the Goblin was modified to improve its longitudinal trim, which made achieving the correct angle for hook-up less of an effort. After the fourth flight, the problem with 'skidding' on the approach with hook extended was addressed by adding vertical surfaces to the wingtips on both aircraft.

The team halted test flying and made field modifications to the XF-85's skyhook, working under difficult conditions. Muroc was a sparse facility in those days, lacking the support infrastructure that has grown up at today's Edwards Air Force Base. More than once, the men suspended work when temperatures fell far below freezing in their unheated hangar. Holidays passed and in January 1949 the XF-85 was ready. It was modified with small fins on the wingtips, a metal fairing along the sides of the skyhook's retraction well, and a 50 per cent increase in the ruddervators' trimming power.

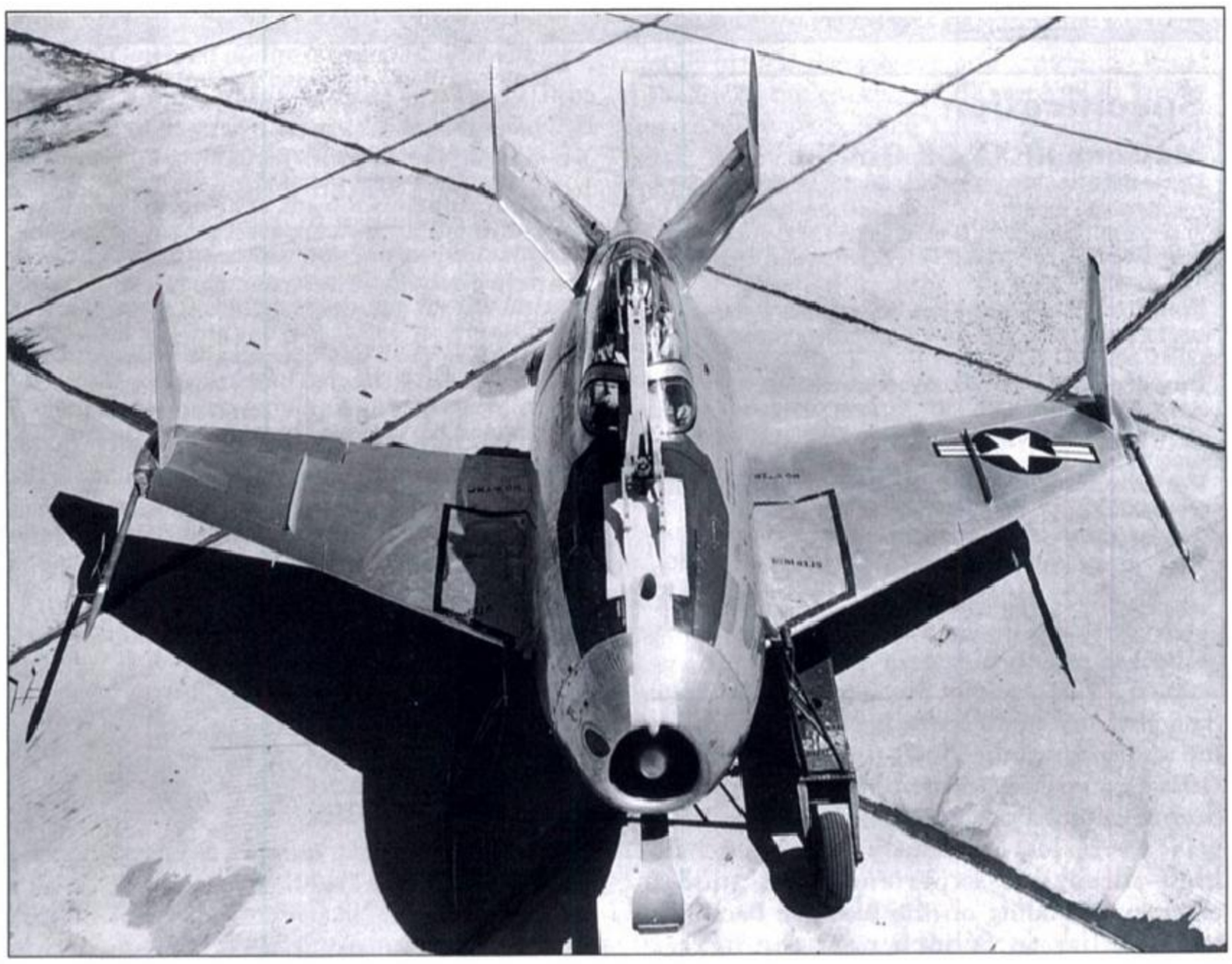
The B-29 took the Goblin aloft for two more captive flights. Schoch made additional practice runs in an F-80. The team took the XF-85 up for free flight number six on 18 March 1949, and from the first instant it seemed the Goblin was jinxed.

When Schoch released the skyhook, the nose-stabilising element of the trapeze fouled the aircraft's nose and was carried away. This rendered hook-on attempts unwise, and Schoch



XF-85 flight log

Date	XF-85	Flight number	Flight time	Weight	Purpose/notes
22 July 1948	524	Captive no. 1		5,327 lb (2416 kg)	Captive flight
30 July 1948	524	Captive no. 2		5,327 lb (2416 kg)	Captive flight
2 August 1948	524	Captive no. 3		5,527 lb (2416 kg)	Power off stability
10 August 1948	524	Captive no. 4		6,017 lb (2729 kg)	Engine run
18 August 1948	524	Captive no. 5		6,017 lb (2729 kg)	Engine run and stability
23 August 1948	524	524-1	0:25	6,017 lb (2729 kg)	First flight – landed in desert
11 October 1948	524	Captive no. 6		5,900 lb (2676 kg)	Captive flight stability
13 October 1948	524	Captive no. 7		5,900 lb (2676 kg)	Captive flight stability
14 October 1948	524	524-2	0:20	5,900 lb (2676 kg)	Directional stability and hook- on – successful
15 October 1948	524	524-3	0:06	5,900 lb (2676 kg)	Hook-on – successful
15 October 1948	524	524-4	0:03	5,900 lb (2676 kg)	Hook-on – successful
22 October 1948	524	524-5	0:36	5,900 lb (2676 kg)	Directional stability – landed in desert
8 March 1949	524	Captive no. 8		5,945 lb (2697 kg)	Captive flight stability
9 March 1949	524	Captive no. 9		5,945 lb (2697 kg)	Captive flight stability
14 March 1949	523	Captive no. 1		5,993 lb (2718 kg)	Captive flight stability
18 March 1949	524	524-6	0:19	5,945 lb (2697 kg)	Stability – landed in desert
8 April 1949	523	523-1	0:30	5,993 lb (2718 kg)	Stability – landed in desert



Above: Turbulence around the skyhook well proved a bugbear of the XF-85. One temporary solution was to cover the well with tape, as seen here, although the hook would not have been retractable with this applied. Provision for the wings to fold for stowage in the B-36 was incorporated in the XF-85 design, although actuators and other folding mechanisms appear not to have been fitted.

again landed on the lake bed. This unsuccessful hop turned out to be the final flight of the second Goblin, 46-524.

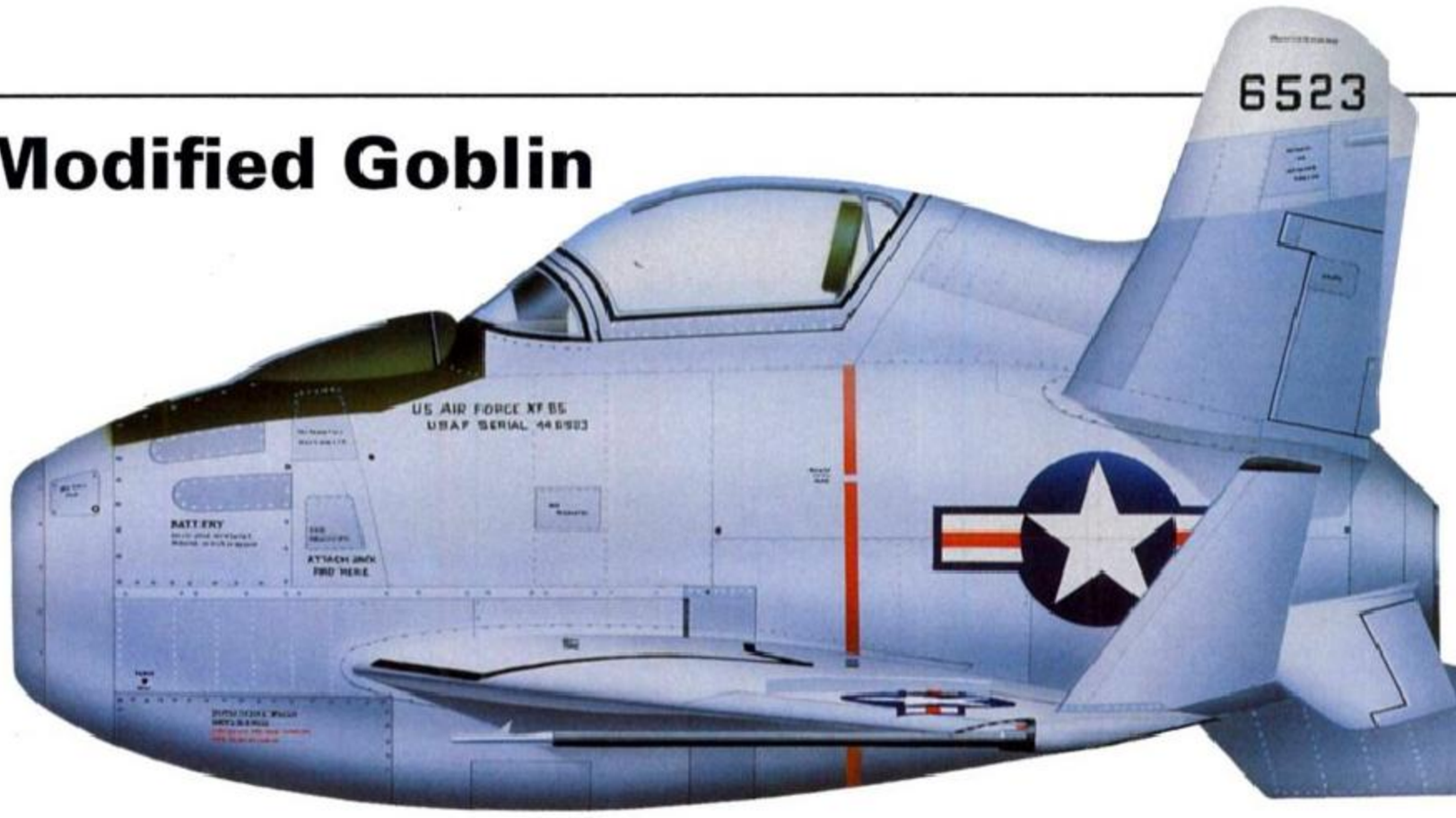
A C-82 had brought the first, and still unflown, XF-85, 46-523, to Muroc. Except for a larger fairing on the leading-edge root of its dorsal fin, it was identical to the other ship. On 8 April 1949 the team took it aloft for a free flight of 30 minutes. Although not attempting to make a speed run, Schoch pushed the aircraft to 314 mph (503 km/h), the highest speed ever reached by either Goblin. The flight appears to have gone off without mishap, again with Eash at the trapeze and Schoch in the cockpit, but it was a swan song. After 15 minutes of frustrating effort and three attempts to hook on to the B-29, Schoch revisited the lake bed.

This rare sequence of pictures shows one of the three successful hook-ups completed during the XF-85 programme which took place on 14 and 15 October 1948. In the last frame, the skyhook has caught but the 'horse collar' has yet to swing into place. Note how far below the B-29 the trapeze hangs. If the project had progressed further, an even longer trapeze would have been trialled to allow the hook-up to occur outside the area of turbulence below the bomber.

At this juncture, McDonnell urged that tests be suspended. No flaw had been found in the XF-85 Goblin, despite its odd shape. The problem was with the trapeze arrangement.

It was thought that if a trained test pilot had difficulty hooking on, an average combat pilot would never get back on the trapeze; in a war, F-85s would be littered all over the Russian steppes. There was no point in continuing the tests until the trapeze was redesigned. The proposed redesign had a long floating telescoping element to allow the parasite to hook on far below the area of turbulence

Modified Goblin



In the course of their short careers, the two XF-85s underwent a surprising number of airframe modifications. In addition to the extra tailfins added after wind tunnel testing, wingtip fins were fitted to increase directional stability after initial flight tests. Additional changes included moving the pitot tubes from the nose and mid-wing positions to the wingtips. Turbulence from the skyhook well was treated with tape and filler and cured by a blister fairing forward of the windscreen. This aircraft, 46-523, shown in its ultimate configuration, was also given a refaired aft fuselage to reduce snaking on the approach.

around the mother plane. Once hooked to the end of the telescopic element, the aircraft would be drawn up into the arms of the main trapeze element.

McDonnell proposed a new aircraft as a follow-on to the XF-85. There were at least two variations of this Mach 0.9-capable parasite fighter, one a conventional jet fighter with a 35° swept wing and the other a sleek Delta-winged design. In the end, though, McDonnell built neither the redesigned trapeze nor the XF-85 follow-on aircraft.

Ineffective fighter

In fact, by 1949 there was little heart in the US Air Force for built-in fighter protection for the B-36. American intelligence experts did not, then, have good information about the Soviet MiG-15 but they did know that even when performing at its best the parasite fighter would be of marginal utility in air-to-air combat. The infrastructure needed to support it would be tremendous, and numerous changes would have to be made to doctrine, strategy and tactics.

Launch and recovery of the XF-85 over hostile territory would be slow and hazardous, and while underway would preclude the B-36 from taking evasive action. The XF-85 was too small to carry air-to-air radar, which limited its value to daylight operations. Finally, no-one ever solved the dilemma of getting the parasite back aboard the bomber in the midst of combat: while the parasite engaged enemy fighters, the bomber would continue to its target. The XF-85's combat endurance was 52 minutes at best and it was not quick enough to overtake its mother ship and make the hook-on. Finally, the 6,000-lb (2720-kg) parasite occupied bomb bay space that could be devoted to 19,000 lb (8620 kg) of ordnance.

Total flying time of the two McDonnell XF-85 Goblins was two hours and 29 minutes. Figures by researcher Richard K. Smith based on the cost of the programme indicate that Schoch was flying the Goblin at $23,098 per minute.

The US Air Force went on to conduct other parasite fighter studies in its FICON (FIghter CONveyor) project, and for a brief period in the 1950s the much-modified Republic RF-84F Thunderstreak was fully operational as a parasite reconnaissance aircraft carried by the B-36. **Robert F. Dorr**

Preserved Parasites

The two XF-85s somehow survived the test programme to be passed to the USAF, but have suffered varying fortunes since. The first aircraft, 46-523, has been preserved at the US Air Force Museum at Dayton, Ohio since 1950 (above and right) although this is the aircraft that did the least flying. The more distinguished second Goblin, 46-524, was used as a travelling display item at air shows and state fairs (above right) before being sold to Tallmantz Aviation which displayed it in southern California. By 1973 it had been returned to the USAF and became an exhibit at the Strategic Air Command Museum at Omaha. Since then it has been displayed outdoors next to a B-36 and wearing inaccurate markings – initially as '4622'/'22' as seen far right, but more recently with no tail serial and the code '24' on the nose, which, while still incorrect, at least reflects its true identity.

English Electric
LIGHTNING

Conceived in the headlong post-war rush for ever greater speed, the Lightning was born in an era when the future of the manned fighter lay heavily in doubt. Raised under a veil of underfunding and lack of political enthusiasm, the aircraft escaped cancellation to mature in the crucible of the Cold War stand-off. Rapid advances in rival fighters and potential targets combined with insufficient development funding to render the Lightning obsolete soon after its service debut, yet the sound design and astonishing performance allowed it to reach a ripe age in the defence of Britain's airspace. Few fighters will ever be remembered as fondly by those fortunate and able enough to fly it.

The heyday of the Lightning was in the mid-1960s, when a new-found pride in RAF Fighter Command saw the silver jets adorned with bright markings. Here a pair of No. 74 Squadron F.Mk 3s swings over the university and golfing town of St Andrews from the nearby base at Leuchars, the clubhouse of the Royal & Ancient just visible under the tailplane of the aircraft in the foreground. The Lightning family gained several distinctions: first British aircraft to exceed Mach 2, unofficial world speed record holder and the only supersonic fighter of British origin. It is also most likely to be the last wholly British fighter.

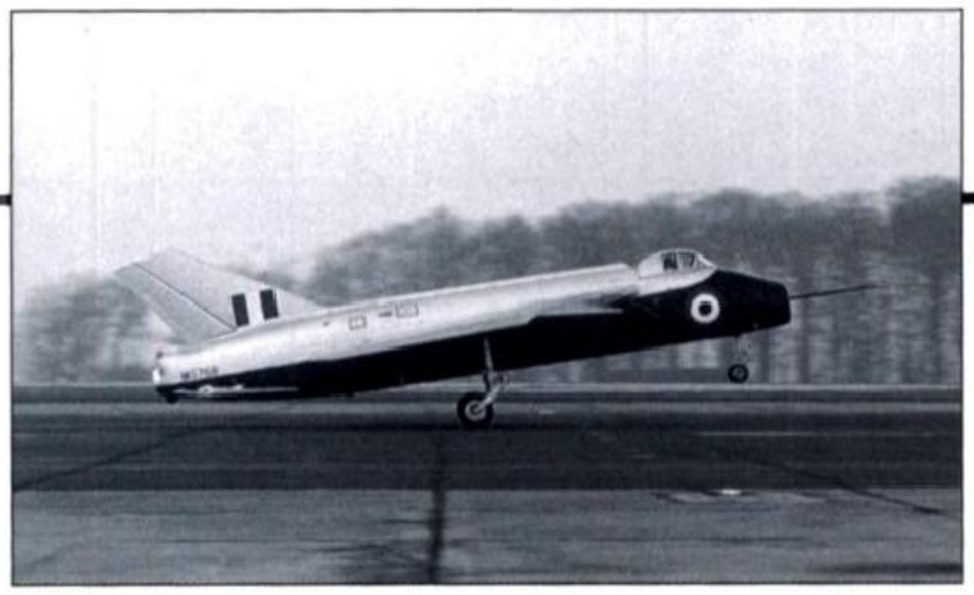
A pair of No. 11 Squadron Lightnings returns to Binbrook after an air defence sortie, exhibiting the two principal weapons of the Lightning. The aircraft in the background carries acquisition rounds of the Firestreak missile, while that in the foreground carries the more sophisticated Red Top. From 1970 the F.Mk 6 reintroduced gun armament in the form of two ventrally mounted 30-mm ADEN cannon, each with 120 rounds.

The Lightning has carved a niche in history as the RAF's last single-seat, indigenously designed and built fighter. It was significant as the backbone of the UK's air defence at the height of the Cold War, and its polished silver finish and gaudy heraldic squadron markings imbued the Lightning with a rarely equalled glamour. If this were not enough, the Lightning was a breathtaking performer in an era when speed, acceleration and rate of climb were the yardsticks against which any fighter was judged, although many of its contemporaries were easier to operate and had sophisticated auto attack systems plus better weapons. Nevertheless, when it entered service many regarded the Lightning as the best fighter in the world. Generations of trainee fighter pilots dreamed of getting a posting to the RAF's elite force, and to measure themselves against its most challenging and demanding aircraft.

The Lightning had its origins in World War II, when Britain led the world in jet propulsion. Britain's first jets, typified by the Gloster Meteor and de Havilland Vampire, were aerodynamically conservative; the Germans, who had nothing to lose, saddled their less powerful and less reliable axial flow engines to explore swept wings and tailless delta configurations. Britain wanted to minimise the development risk of its first in-service jets, and was content to settle for a relatively small performance edge over existing piston-engined fighters.

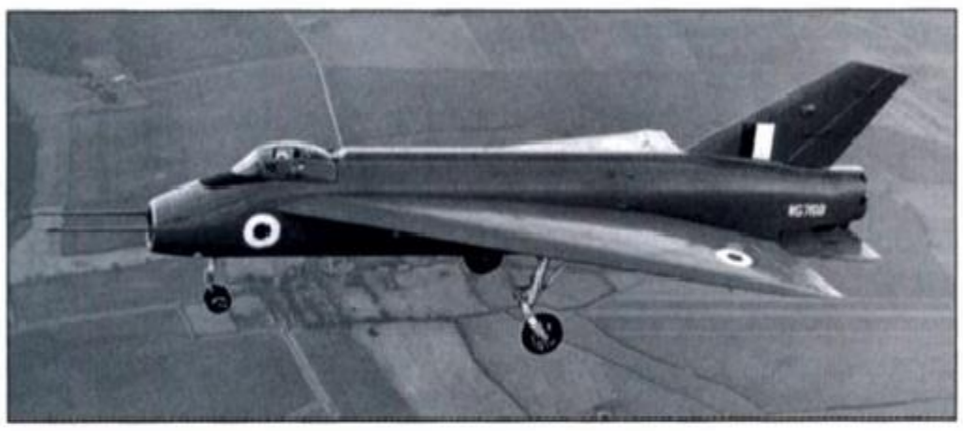
While the conservative Meteor and Vampire (and the Attacker for the Fleet Air Arm) took shape, the Ministry of Aircraft Production issued specification E.24/43 for a research aircraft capable of exceeding Mach 1.0, and of attaining 1,000 mph (1610 km/h) at 36,000 ft (11000 m). The contract was given to Miles Aircraft, known mainly for

In an earlier era, a pair of Lightnings breaks after take-off from Binbrook. The Lightning was a true fighter pilot's aircraft: demanding and difficult to master, yet ultimately highly rewarding. In the right hands it remained a formidable opponent, surprising many a pilot of much younger and more capable aircraft. Even in the big-belly, heavyweight F.Mk 6, very short endurance remained the Lightning's Achilles heel to the end of its days in service. It was often said that a Lightning pilot would never run out of fuel, whatever he was flying or driving, so robotically drilled was he in constantly checking his fuel state.



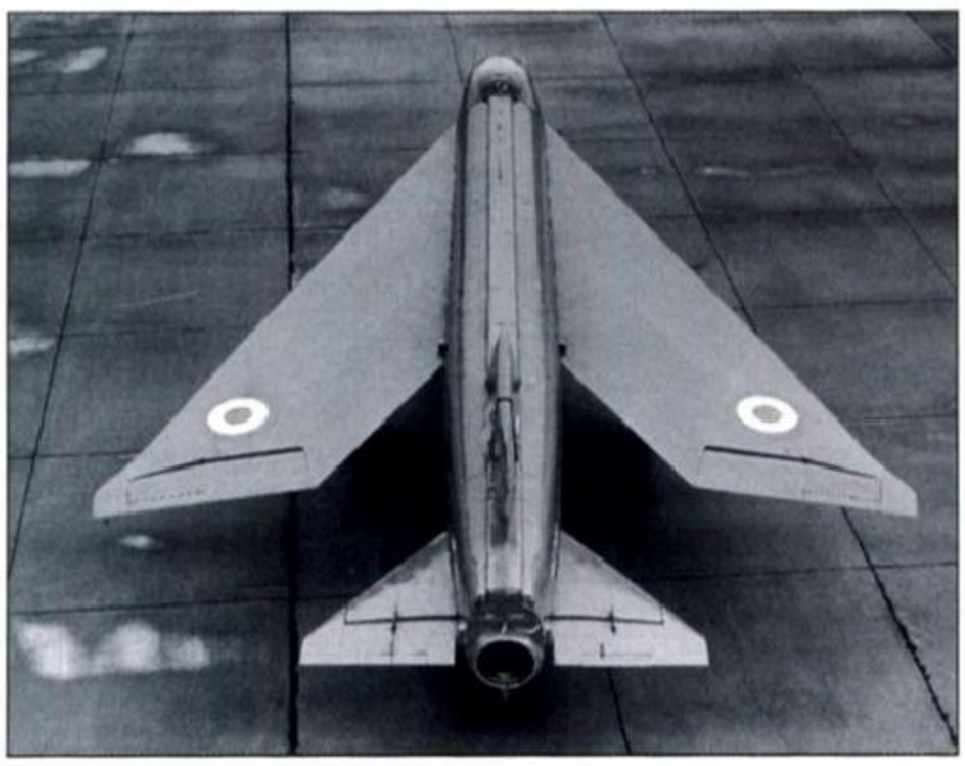
Short SB.5

First flying on 2 December 1952 with Tom Brooke-Smith at the controls, the SB.5 was built at the behest of the RAE to investigate the aerodynamic configuration of the P.1 at low speeds. It could be fitted with wings swept at 50°, 60° or 69°, and with low- or high-set tailplane. Viewed by English Electric as an irrelevance, it proved that the 60° wing and low-set tailplane already chosen for the P.1 was indeed the optimum layout. Lightning test pilot Roland Beamont flew the SB.5 in 1954 to gain experience prior to flying the full-sized aircraft.



building light aircraft and trainers but with a reputation for innovative design. The resulting Miles M.52 was similar in configuration to the Bell X-1, and promised to give Britain a huge lead. Remarkably, though, the M.52 was cancelled in February 1946 and the mock-up, jigs and tools were destroyed. The Attlee government was desperate to save money, while many within the industry resented Miles's position. Others expressed doubt that an unswept configuration was appropriate. It was suggested that further research would be undertaken using unmanned models and rockets, a position resolutely supported by Barnes Wallis, who hoped that his own company, Vickers, would build the required models.

The Ministry of Aircraft Production's Director General of Scientific Research stated that "Flying at speeds greater than sound introduces new problems. We do not yet know how serious they are. The impression that supersonic aircraft are just around the corner is quite erroneous, but the difficulties will be tackled using rocket-driven models. We have not the heart to ask pilots to fly the high-speed models, so we shall make them radio controlled." This was somewhat disingenuous, since the M.52 itself was just around the corner. That aircraft was cancelled, but since its very existence had never been acknowledged the Official



Secrets Act ensured that it remained unknown until September 1946. All of the calculations, technical information and wind tunnel test results pertaining to the M.52 were given to the USA. Bell's X-1 made its record-breaking supersonic flight on 14 October 1947. Meanwhile, Wallis's rockets proved trouble-prone and the money spent went largely on getting the models to work, and not in gathering useful data. The project succeeded only in showing that the M.52's original configuration would have achieved its aims, and cost almost as much as it would have cost to complete and fly the M.52.

Research aircraft contract

Several specifications for new swept-wing fighters were issued in 1946, eventually resulting in the Hawker Hunter and the Vickers-Supermarine Swift. The Hunter in particular was to prove an effective fighter and an excellent fighter-bomber, but by the time it entered squadron service in 1954 it was facing supersonic competition from the F-100 and MiG-19. Fortunately, the English Electric design team responsible for the Canberra bomber had turned its attention to a supersonic fighter from about 1946. In May 1947 W. E. W. 'Teddy' Petter won English Electric a study contract for a Mach 1.5-capable research aircraft to meet specification ER.103. By December 1948, this aircraft was recognisably similar to that of the eventual production Lightning, with a sharply-swept untapered wing, low-set tailplane, pitot intake and staggered twin engines mounted one on top of the other.

The Ministry of Supply was impressed by the design, and in early 1949 signed a contract for two prototypes (and a static test airframe) to meet requirement F.23/49 to "investigate the practicality of supersonic speed for military aircraft." As such, English Electric's P.1 was a research aircraft, although the provision of guns and a sighting system (radar was viewed as being necessary only for ranging the guns) plus a 7-*g* load limit were specified.

The Ministry of Supply may have been impressed by the

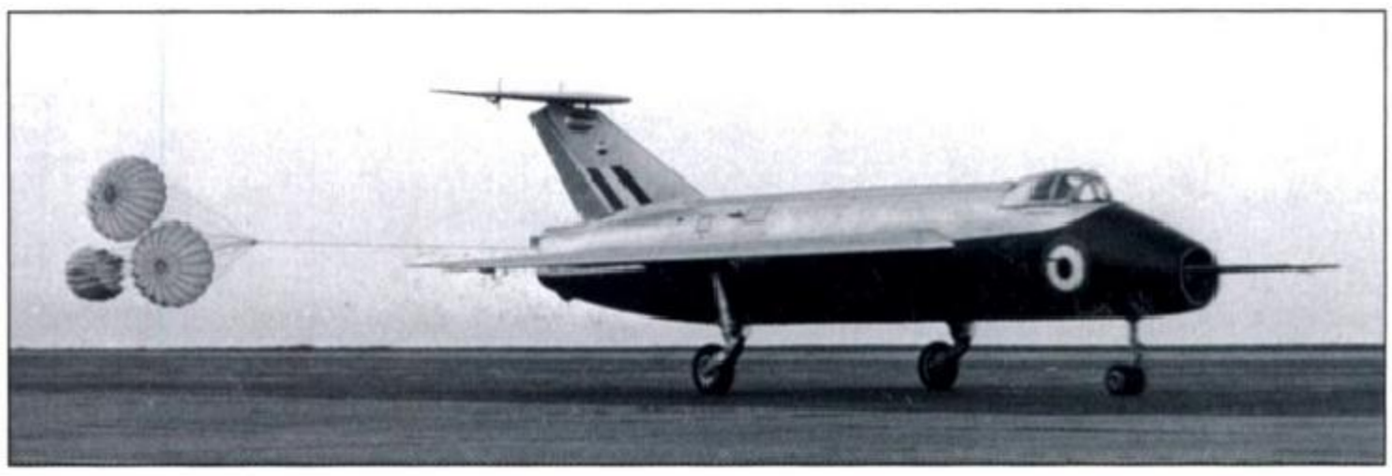
Above: In its first incarnation the SB.5 flew with a 50° wing and T-tail, the configuration favoured by the RAE. The wing had full-span drooping leading-edge flaps.

Top left: After the 50° trials, the SB.5's wing was set at 60°, at which it flew with both high- and low-set tails. Here it is seen with the latter, deploying the wingroot flaps which were intended for the P.1.

Above left: The final configuration flown on the SB.5 had the wing swept at 69°. The aircraft still exists, preserved alongside a P.1A and P.1B in the Cosford Aerospace Museum.

Below left: The dramatic sweep of the 69° wing is graphically demonstrated here. Power for the SB.5 came from a single Rolls-Royce Derwent.

Below: The SB.5 did not directly affect elementary design of the P.1, but did verify the basic configuration and provided some useful refinements. Here it deploys the three-canopy landing chute used for braking.

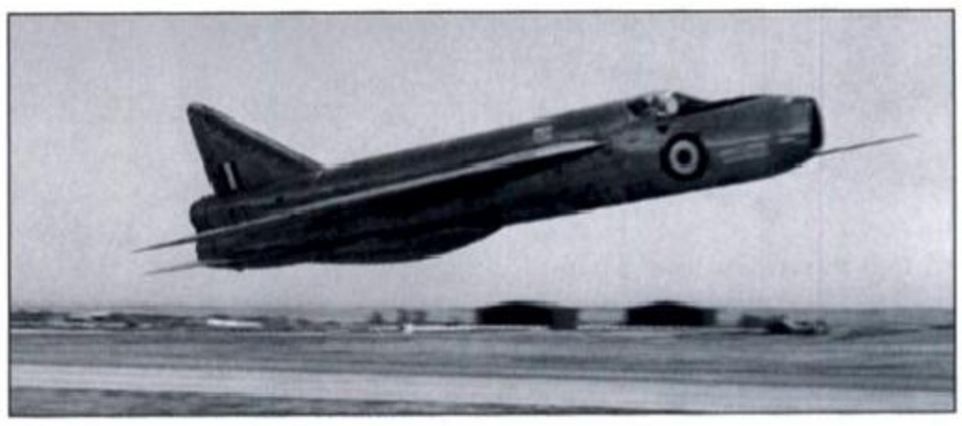


English Electric Lightning

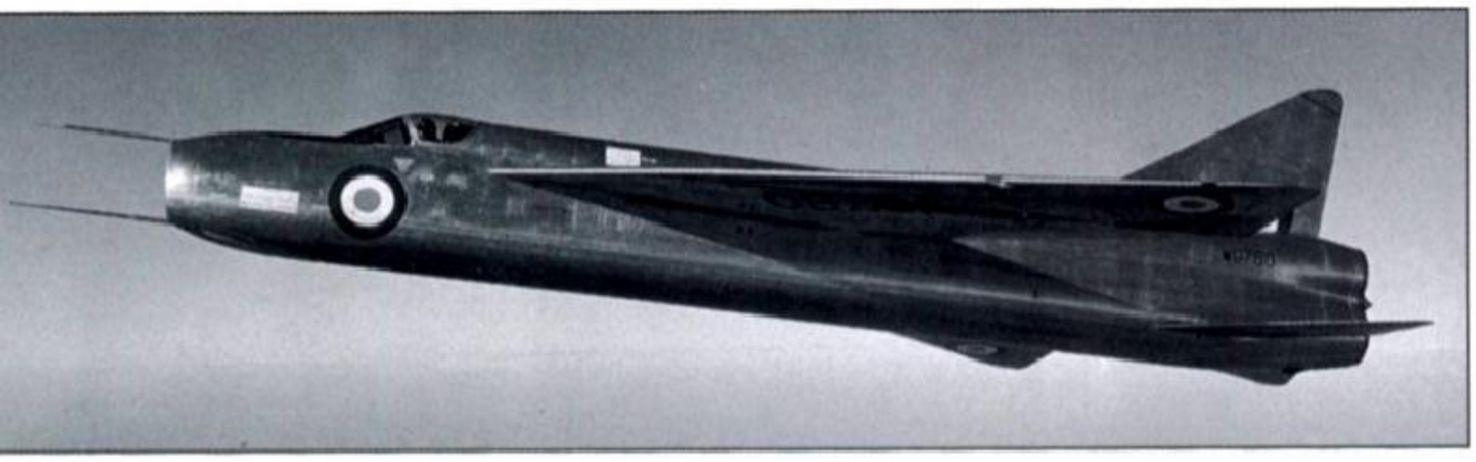
P.1A

Designed in answer to Experimental Requirement 103, the P.1A began life as a pure supersonic research aircraft, but from an early point it became obvious that it would form an excellent basis for a fighter. The first aircraft flew on 4 August 1954 from Boscombe Down, from where initial flight trials took place before switching to Warton. The second prototype flew from the Lancashire airfield on 18 July 1955, featuring a fuller equipment fit.

Above: Power came from two Sapphire Sa.5 jets. Reheat was added later in the programme.



Above: The second P.1A, WG763, could carry an additional 250 Imp gal (1136 litres) of fuel in a ventral tank, and also had provision for two nose-mounted 30-mm ADEN. WG763 retained the leading-edge flaps, but they were locked shut and deleted altogether from subsequent aircraft.

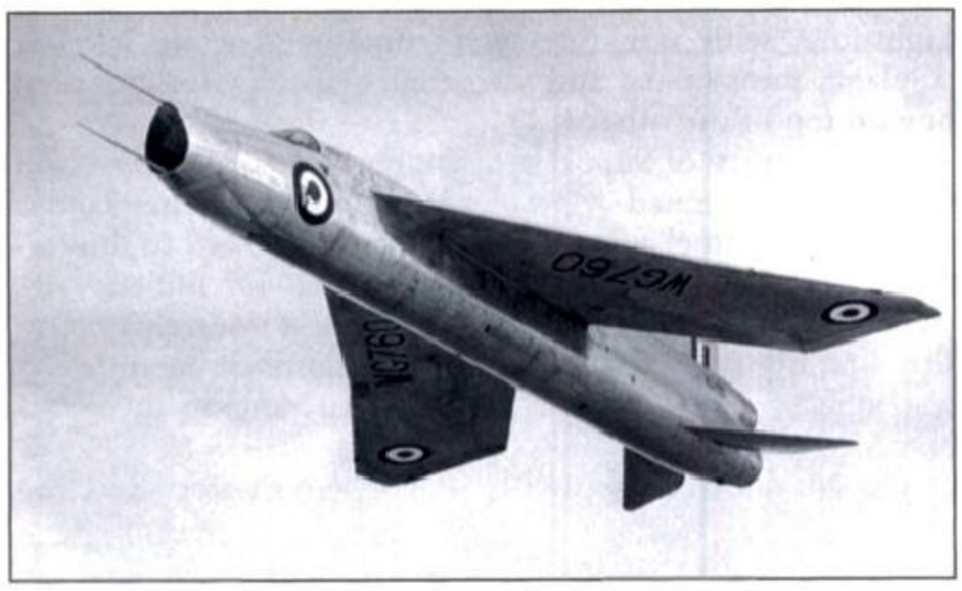


Beamont brings the prototype P.1A in close to the Meteor photo-ship. The aircraft achieved Mach 1.02 on 11 August 1954, its third flight. It was capable of speeds in excess of Mach 1.2, although longitudinal stability became poor.

The first P.1A remained on the test fleet until September 1962, when it was grounded and used for technical training.

Right: As early as February 1957 the P.1A flew with the 'kinked' variable-camber wings which increased lift, yet they were not adopted as standard until the F.Mk 6.

Below: For many years the first P.1A was displayed on the parade ground at RAF Henlow. It was fitted with an intake centrebody and wore red/black AFDS nose markings.



P.1, but the Royal Aircraft Establishment was not. The RAE refused to believe Petter's calculations and wind tunnel tests, and distrusted the low tailplane and sweep angle. To prove the 'superiority' of their favoured T-tail, and a lower leading-edge sweep, the RAE commissioned the Short SB.5. At the time this was officially described as a pure research aircraft, and was not officially linked to the P.1 at all. Similar in configuration to the P.1, the SB.5 had three sets of wings with sweep angles of 50°, 60° and 69°, and two tailplanes, one low set, one high on the fin. Fortunately, English Electric continued with the P.1 in its original configuration (60° sweep and low tailplane), which proved to be superior to the others when eventually flown (from 10 January 1954) on the SB.5. Had it not been, however, it would have been too late to make a difference, and the SB.5 served only to demonstrate into how wretched a state the RAE had got.

The P.1 was trucked to Boscombe Down, where it flew for the first time on 4 August 1954. It was a remarkable success – and it had to be, because in the USA the F-100 programme was moving ahead very rapidly, while many senior Air Ministry personnel deeply doubted the practical utility of supersonic performance and were suspicious that it would lead to unacceptable compromises in other aspects of performance. Although the basic P.1 configuration had been finalised in 1949, it was far bolder in concept than that of the MiG-19 or the F-100, and this helped the final production Lightning to remain viable, despite its very long gestation.

It was a very long time between the first flight of the P.1 and the emergence of the production Lightning. This should not have been surprising, since the P.1 was very much a research aircraft, with no room for weapons systems, avionics or even adequate fuel, and solving these problems was bound to take time. The P.1 had only 2,500 lb (1135 kg) of fuel per side, giving a total that was less than the normal minimum recovery fuel in the Canberra. Although it was a research aircraft, the P.1 did have clear potential as a service fighter, with an excellent rate of roll, good control responsiveness and load factors, and could be flown easily by an ordinary RAF pilot.

Speed challenge

The original ER.103 requirement (and the F.23/49 specification) called for a maximum level speed of Mach 1.2; a great challenge, but one which proved attainable even with non-afterburning Sapphire engines. Even before the aircraft made its first flight, it was becoming increasingly clear that, with more powerful engines, speeds in excess of Mach 2 would be possible, and that rapid acceleration would be possible even at Mach 1.5 and above. Such a level of performance was impossible without a variable intake and a variable afterburner nozzle, preferably of the convergent/divergent type, although by happy coincidence drag was minimal and the aircraft was almost perfectly 'area ruled'. It would also need a considerably larger fin for adequate longitudinal speed at Mach 2. Once the decision was made to produce a fighter version of the aircraft, the basic research prototype was redesignated P.1A, with the fighter becoming the P.1B.

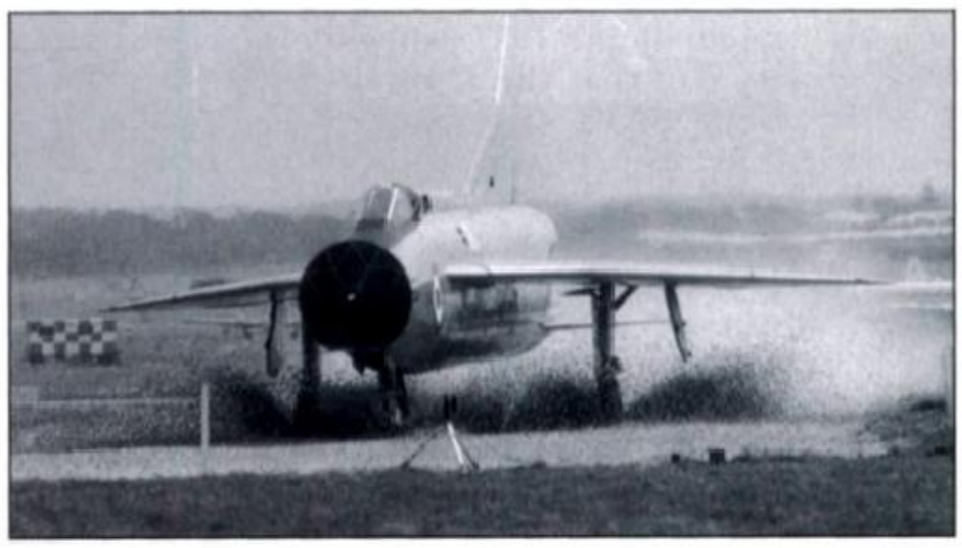
Three P.1B prototypes were ordered, to be equipped with the new AI.23 radar and armed with two 30-mm ADEN cannon, 48 2-in rockets, and two de Havilland Propellers Blue Jay IR-homing AAMs. The aircraft was envisaged as a short-range point defence interceptor, with no collision course intercept capability and no long-range

Roland Beamont flashes past the photo-ship in the first P.1B, which carries a radome-mounted test instrumentation boom in addition to the standard pitot tube. Joining Beamont in January 1957 on the Warton test team as deputy chief test pilot was Jimmy Dell. Both men would be intimately linked with the Lightning throughout the test period, and between them flew 23 of the 24 flights of the TSR.2.

role. In the USA, the pilot was increasingly being seen as redundant – a systems manager at most, who broke into the control loop to land the aircraft (and even here, autoland using ILS and interlinked autopilot showed great promise). In Britain, though, most still believed that a night/all-weather interceptor needed a second crew member, as in the appalling Javelin, and it took years to persuade the Air Staff that the P.1B would be suitable for the night/all-weather role.

Development of the Hunter and Swift had been unusually protracted, not least because only a handful of prototypes had been constructed. It was decided, therefore, that there would be 20 P.1B development aircraft. This decision was almost certainly made in complete ignorance of the US Cook-Craigie plan (whereby multiple prototypes at different centres undertook various aspects of testing simultaneously), but nonetheless led to the production of three hand-built prototypes, five P.1Bs built in production jigs, and a virtual production batch of 15 more P.1Bs.

Meanwhile, the second P.1A made its maiden flight on 18 July 1955, with a neat ventral fuel tank fitted and plain flaps on the trailing edge instead of the original spilt flaps. The aircraft even had cannon fitted. In January 1957 the first P.1A flew with a revised wing, with reduced sweep



XA847 was used for a wide variety of trials, including the first flights with inflight-refuelling probe in 1959. Although grounded, it was used by RAE Farnborough in the late 1960s as a trials aircraft for a gravel emergency arrester system.

outboard and slight camber on the leading edge. This generated greater lift at high angles of attack, with reduced drag and less buffet, but was judged to be too costly to incorporate on the P.1B and did not reappear until the F.Mk 6.

The pace of development was relaxed, mainly because the customer expected it to be. There was little reason that the P.1B could not have been built more quickly and in larger numbers, and a production fighter could have been in squadron service by 1957, albeit without the Blue Jay missile. But in Britain, a supersonic fighter was still viewed

Below: XA847 was the first of the three P.1Bs to fly, achieving Mach 1.2 on its maiden trip. Initial service clearance to Mach 1.7 was gained rapidly, although the aircraft was considerably faster. In July English Electric coyly announced that it had unofficially broken the world speed record (which then stood at around Mach 1.72), although the true top end figure of the Lightning remained classified for many years.

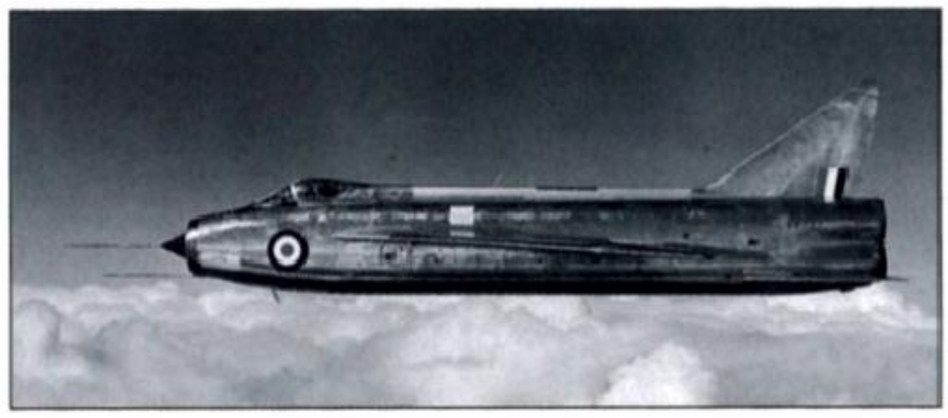
P.1B

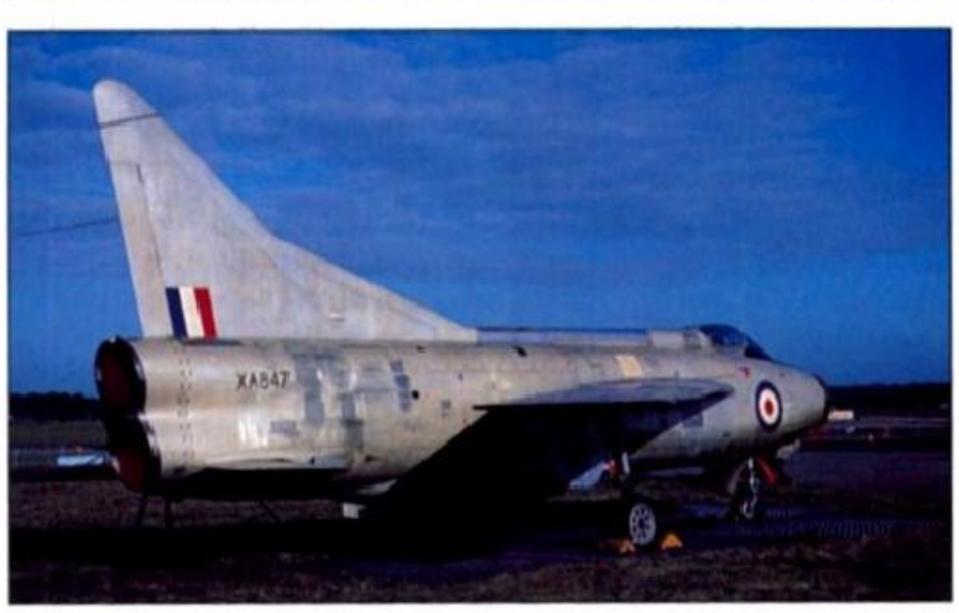
The P.1B was the prototype for the F.23/49 day fighter, essentially similar to the P.1A aft of the forward fuselage. Power came from the RA.24R Avon engine and the airbrakes were relocated. The P.1A's split flaps were replaced by simple hinged surfaces which doubled as fuel tanks. 'Bee' Beamont flew the first aircraft on 4 April 1957.

Left: With airbrakes out and main gear doors opening, the first P.1B turns finals for Warton over the Ribble estuary.

Below left: XA847 was later fitted with an extended dorsal fin in conjunction with trials for a ventral weapons pack. The extra fin area was found to be unnecessary.

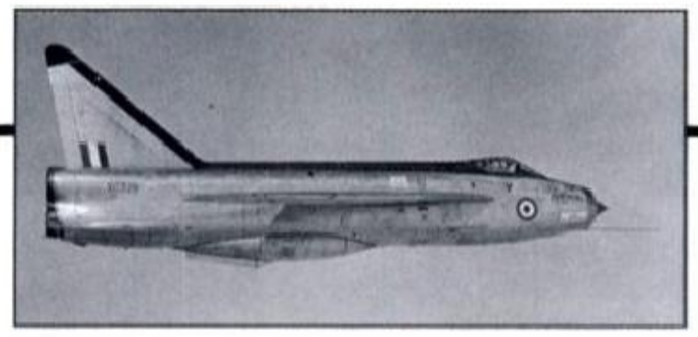
Below right: XA853 was the second P.1B, seen here carrying Firestreaks and the ventral fuel tank.





Seen carrying dummy Blue Jay (later Firestreak) missiles, this was the third of the DB aircraft. The aircraft remained dedicated to weapons testing throughout its career, being used for carriage and release checks of the Firestreak, in addition to gun firing.

After a brief period on TACAN trials, XG325 joined the large weapons test fleet, flying with DH Propellers at Hatfield, initially on Firestreak trials. Here it is seen with the later Red Top missile. This weapon, introduced on the F.Mk 3, was advertised as having an all-aspect capability, although in truth this was restricted to supersonic targets, as subsonic targets did not generate enough skin friction for acquisition.



XG329's task was to test the nose cannon installation, being occupied on harmonisation work. It later conducted datalink tests.

XG332 was employed to test the UHF radio and LOX system incorporated into the F.Mk 1A. As part of this programme the aircraft went to Aden for tropical trials.

Development Batch

Ordered in February 1954, the Development Batch (DB) aircraft were procured to hasten the development of the Lightning, and numbered 20 airframes. The aircraft made their first flights between 3 April 1958 (XG307) and 29 September 1959 (XG333), and were put to work testing every aspect of the Lightning.

Below: One of the DB Lightnings turns finals, displaying the undercarriage geometry. As can be seen, the mainwheels had to swivel through 60° before retracting.

as being incredibly futuristic, even if seven such fighters were in service elsewhere by 1957. The first P.1B made its maiden flight on 4 April 1957 (without radar or armament) on the very day that the Conservative government published Duncan Sandy's remarkably fatuous White Paper entitled 'Defence – An Outline of Future Policy'. This heralded the imminent replacement of virtually all manned aircraft by missiles, and contained the breathtakingly stupid statement: "In view of the good progress already made, the Government have come to the conclusion that the RAF are unlikely to have a requirement for fighter aircraft of types more advanced than the supersonic P.1, and work on such projects will stop."

Unfortunately, the White Paper came to reflect what did happen, and not merely what the Government thought might happen, and many promising projects were cancelled. Remarkably, the Air Staff failed to make any significant opposition to the policy, treading the usual British military path of gutless acceptance of political directives, however damaging or daft. The exception made for the P.1 was not because the aircraft was felt to be necessary, but because the project had progressed too far to cancel.

This had one positive effect on the P.1B: it became the only game in town, with aircraft like the mixed-powerplant SR.177 being cancelled forthwith. Unfortunately, it also led to the P.1B being seen as an unimportant stop-gap pending the introduction of the marvellous new missiles, and many believed that it would have disappeared from service by 1964. This left little incentive to make the aircraft any more than adequate (hence the non-adoption of the superb new cambered wing, or of nosewheel steering, which was developed, tested and cleared, then ignored). In October 1958, the Chief of the Air Staff, Sir Dermot Boyle, formally named the aircraft 'Lightning', ending much speculation and saving the aircraft from being lumbered with the appellation 'Excalibur'.

By this time, the programme was well advanced. An initial batch of 50 F.Mk 1s had been ordered in November 1956, and a bigger order for what became the F.Mk 2 and T.Mk 4 followed in April 1958. The first of the 20-aircraft development batch (XG307) made its maiden flight on 3 April 1958, with AIRPASS radar, guns and missile pylons.

This aircraft, with the original small fin, was powered by a 14,430-lb st (64.19-kN) Avon Mk 201 (RA.24R) with four-position afterburner, and carried 7,500 lb (3400 kg) of fuel. Such a quantity was sufficient for a maximum-rate climb to 30,000 ft (9145 m), an acceleration to Mach 1.5, a single-pass intercept and a return to base with 1,600 lb (725 kg) of fuel remaining. This was fine for the limited role of point defence of east coast V-Bomber bases and airfields in 2 ATAF, but represented far less than was possible. English Electric proposed an advanced Lightning with a bigger, lower-drag ventral tank (test flown on XA847 and XN725), fuel in the flaps, jettisonable overwing fuel tanks, and provision for a range of air-to-surface weapons or reconnaissance sensors. This multi-role Lightning had 40 per cent more range than the F.Mk 1 that the RAF was buying, but no-one saw fit to order the new type. English Electric proposed the aircraft to Germany, but its offer was not supported by the government which was busy pushing the SR.177. This was unfortunate, since the multi-role Lightning promised to fulfil the German requirement better and more cheaply than the F-104 Starfighter which was eventually selected, and a multi-role Lightning could have taken the entire European market which eventually fell to the F-104G.

Frustration mounted as it became increasingly plain that Britain had a world-beater in the Lightning, but that

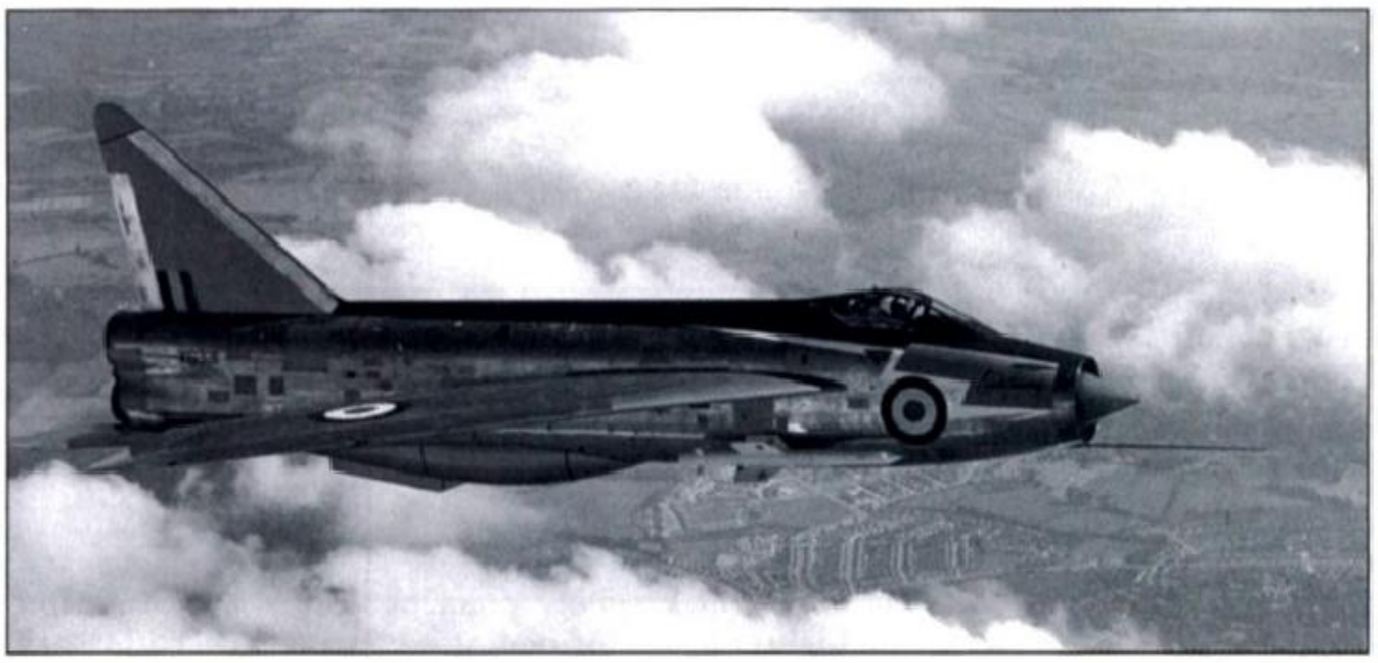
Left: Masquerading as a full-standard F.Mk 1, XG331 lines up on the Farnborough runway alongside the prototype T.Mk 4. This aircraft had been allocated to the radar test programme, flying first with the standard AI.23 and then with the improved AI.23B intended for the F.Mk 3.

no-one would allow even the tiniest expenditure to enable the aircraft to fulfil its true potential. Plans to fit a Napier Double Scorpion HTP/Kerosene rocket motor (the engine which had powered a Canberra testbed to a world altitude record of 70,310 ft/21430 m) were abandoned, though a cleverly retouched photo of XA847 in flight has led many 'historians' to conclude that the installation was actually flight-tested. Installation of the rocket pack indisputably would have further reduced the Lightning's meagre fuel capacity, but this was not the reason for its cancellation. It was due more to a general disinclination to spend any money at all on what would be a short-lived aircraft. Similarly, plans to fit the nuclear-armed, unguided US Genie AAM were abandoned after English Electric had completed a paid study contract to integrate the awesome missile. One aircraft was allocated for a trials programme (with missiles), and a semi-recessed installation for one Genie (ahead of the ventral tank) was designed.

Austere interceptor

The Lightning was still perceived as an interim type with an anticipated service life measured in months, and as a result it was the most basic and austere Mach 2 interceptor possible. Fighter Command was still equipped with Hawker Hunters (representing a level of capability only marginally better than the F-86 Sabre) and with the useless Javelin, so even the limited F.Mk 1 Lightning marked a major jump in capability. When the first production aircraft (XM129 and subsequent airframes) began to reach the service, there was great excitement, even though these aircraft had Avon Mk 200R engines with simple 'on-off' reheat.

In fact, the first Lightnings delivered to the RAF were pre-production P.1Bs, XG334-336 being delivered to the Air Fighting Development Squadron (AFDS) at Coltishall in December 1959. These aircraft were used to gain CA (Controller, Aircraft) release for service. The first production Lightning to reach the AFDS was XM135, delivered on 14 May 1960, and by the end of that month the unit participated in the annual air defence exercise ('Yeoman') with six aircraft. When they got airborne, the Lightnings performed brilliantly, although poor serviceability resulted in the disapproving official assessment that the Lightning had achieved only "a satisfactory rate of interception." The unit used its aircraft to develop tactics and procedures for the new aircraft, and also loaned aircraft to the Lightning Conversion Squadron (another Coltishall-based component of the Central Fighter Establishment) for training new pilots.



The DB aircraft enjoyed a long and productive career. Having first cleared aspects of the initial production version for service, they went on to test further aspects of follow-on variants. In the course of XG331's career it went to Aden in 1960 for tropical AI.23 trials.

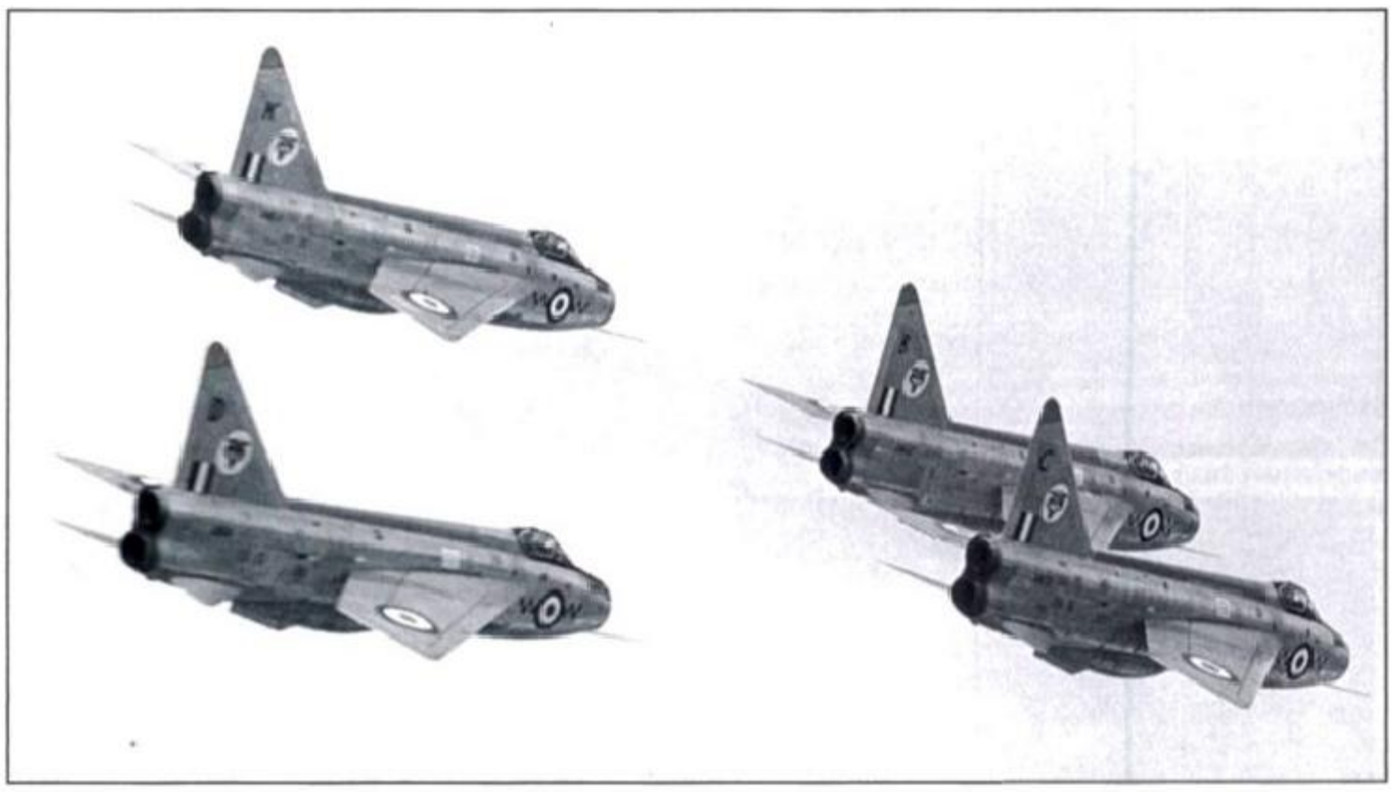
Into service

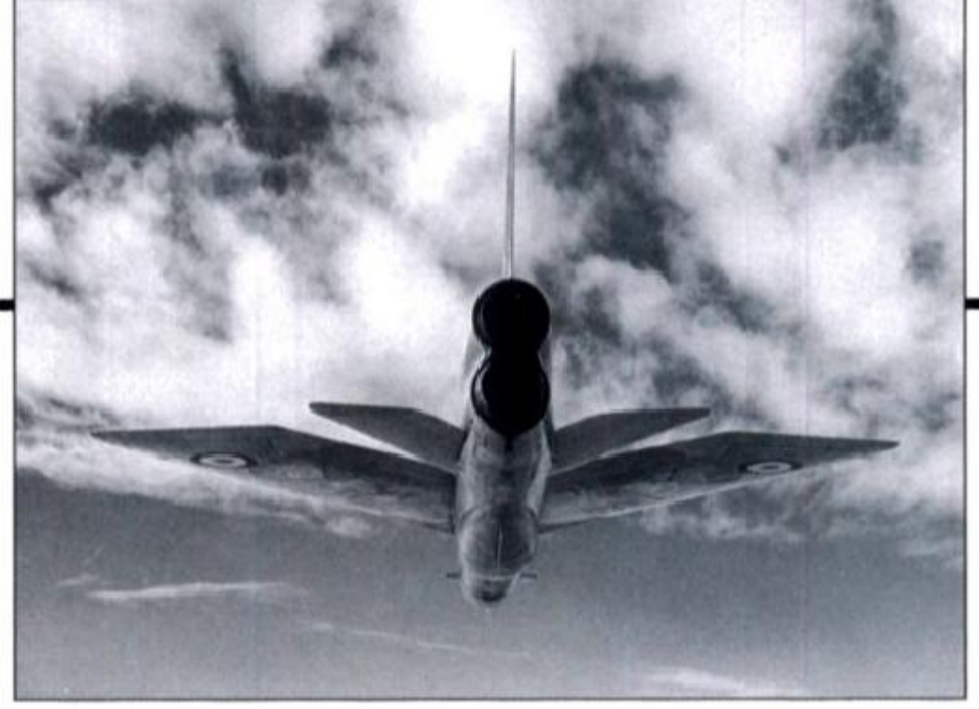
No. 74 Squadron was selected as the RAF's first Lightning squadron. This was a great honour in one respect, but was also a mixed blessing since the new aircraft was bound to be deflected from its operational tasks by the glare of publicity and the need to show off 'Britain's new fighter', and since the F.Mk 1's operational capability was severely constrained by its primitive reheat system, its lack of UHF radio and refuelling probe, and its poor serviceability. Even with its faults, though, the F.Mk 1 Lightning marked a colossal improvement over the subsonic Hunter. The first Lightning allocated to No. 74 Squadron was delivered instead to the AFDS (deployed to Leconfield while Coltishall's runway was being resurfaced) on 29 June 1960,

No. 74 'Tiger' Squadron was chosen as the first operational recipient of the Lightning, acquiring its first aircraft on 11 July 1960. Initial conversion was aided by an 'experienced' Lightning pilot flying chase in a Hunter T.Mk 7.

F.Mk 1

Production Lightnings began to appear from the works in the autumn of 1959, the first example (XM134) making its first flight on 3 November. For the next few months a production rate of two or three aircraft per month was maintained, allowing the delivery of aircraft to service test fleets. XM134 went to the A&AEE at Boscombe Down in March 1960 for Controller (Aircraft) release, which was granted in May. Five F.Mk 1s were then delivered to the AFDS for evaluation and tactics development, while the first squadron received its aircraft in June.





From the rear the Lightning presented an awesome sight. The wings were deliberately squared-off to provide the ailerons with maximum effectiveness, and the aircraft demonstrated a superb rate of roll.

From the start, the Lightning proved to be an excellent formation display aircraft. No. 74 Sqn spent much time practising the art in preparation for displays.

and No. 74 did not get its hands on the aircraft until 11 July, when it led a flypast marking the return of the AFDS to Coltishall. The squadron's South African CO, Squadron Leader J. F. G. Howe, made his first Lightning solo on 14 July, and within one week all of the squadron's pilots had flown at least one sortie.

From the lucky pilots' point of view it was marvellous. The Lightning performed as advertised (or better), the AI.23 radar and Firestreak worked, and the aircraft was relatively easy to fly, with an approach speed of under 150 kt (172 mph; 277 km/h). First solos (there were initially no two-seat Lightnings) were a little 'sporting', but average Hunter squadron 'Joes' (or at least those with 1,000 flying hours, who were the only pilots let loose on the new fighter) soon caught up with the Lightning, and everybody loved it. Everybody except the engineers, to whom keeping the thing serviceable was never anything but a painful, time-consuming chore. This was partly because the RAF still relied to a degree on ill-trained and poorly motivated national servicemen, so was simply not ready for such a technologically advanced aircraft. One of the biggest problems, apart from the complexity and inaccessibility of the Lightning's systems, was the inability of the RAF's creaking logistics system to get sufficient spare parts to the front-line bases, a problem which lasted for most of the aircraft's career.

Whatever the reason, the RAF found it difficult to achieve a utilisation rate of more than 20 flying hours per aircraft per month in those early days, though English Electric vigorously maintained that 40 hours was possible if enough skilled manpower was provided per flying hour. In the end, the company was proved right, when Saudi Lightning utilisation (in the desert) exceeded 40 hour per aircraft per month, and when the RAF itself exceeded 45 hours per aircraft per month. Unfortunately, though, such availability was not achieved early enough, and the Lightning gained a not altogether deserved reputation as being impossible to maintain. This was one of the main reasons for the unwillingness to spend money to improve the aircraft, and for the RAF's order for the McDonnell Douglas F-4, which in truth proved little easier to maintain than the late-mark Lightnings.

Above: Throughout the career of the Lightning, its cockpit was the most sought-after posting in the air force. Shown here is Sqn Ldr Howe, the first 'Tigers' CO, who was responsible for introducing the Lightning as an operational aircraft.

Teething problems

Like virtually every brand-new fighter, the Lightning F.Mk 1 suffered its share of technical problems. Some of these were easy to fix, and some merely imposed limitations on how the aircraft could be flown. Others, though, were more serious, and the aircraft were grounded on a number of occasions, once for three months while the manufacturer made urgent modifications.

In truth, the underlying serviceability of the Lightning was disastrously poor, and the pilots of No. 74 Squadron

F.Mk 1 into service

The full glare of the media shone on No. 74 Squadron at Coltishall from the moment it received its first aircraft in July 1960, and the squadron strived to not disappoint. Early air defence exercises proved that the Lightning was indeed an excellent interceptor over short ranges, defeating all known bomber ingress tactics.

Left and right: A dozen of the 'Tigers' F.Mk 1s are seen in this impressive line-up at Coltishall. The squadron operated 19 of the 20 Mk 1s built at one time or another, occasionally borrowing aircraft from the AFDS for major events such as air shows.

Left: In 1961 and 1962 No. 74 Squadron took centre-stage at the Farnborough air show, flying a nine-ship in synchronisation with 16 No. 92 Sqn Hunters at the later display.

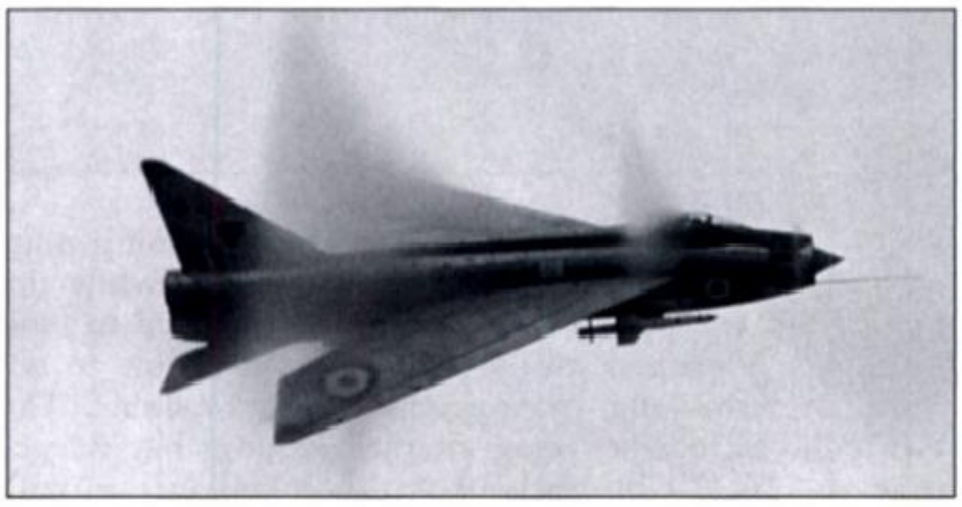
Conversion to the Lightning proved fairly easy for the pilots, but the ground crew struggled in the face of the sophistication of the new fighter. Aircraft availability was woefully low in the early days, but slowly improved as the ground crew became more proficient and as the inevitable teething problems were overcome. XM165, leading here, was 74's first aircraft.

kept in current flying practise by augmenting their occasional Lightning sorties with missions in the squadron's Hunter T.Mk 7, or in the Station Flight Meteor T.Mk 7. Variety is said to be the spice of life, and thus there were few complaints from the pilots, who had the unusual opportunity of flying three generations of fighter during the same posting. The degree to which the squadron was operational with its new Lightnings is perhaps open to debate.

No. 74 Squadron was tasked with providing a nine-aircraft display team from its 12-aircraft establishment, but even by borrowing spare aircraft from the AFDS this proved impossible to sustain. When the squadron formally took over as the Fighter Command aerobatic team, it was with a seven-aircraft formation.

Radar success

The Lightning's early problems were kept very quiet, while its performance, potential and capabilities were loudly trumpeted. In retrospect, the fact that the AI.23 AIRPASS radar worked as intended was a very major achievement, which could be compared with the unhappy experience of the fighter version of the Tornado when it entered service. Ferranti had been working on the AI.23 since 1954, and had successfully flown the radar in a Dakota (TS423) with a representative cockpit display and hand controller. It had then flown the radar in a fast jet platform, in the shape of a modified Canberra B(I).Mk 8, before installing the equipment in a number of the P.1Bs, one of which (XG312) was exclusively assigned to Ferranti. Whatever the reason, the Lightning's operational equipment worked very well. This alone was enough to attract the interest of a number of potential overseas customers for even the Lightning F.Mk 1, the most serious of whom was the Indian Air Force. At one stage, it seemed possible that No. 74 Squadron might even have to temporarily convert back to the Hunter, so keen were the Indians to make an immediate purchase. In the end, the deal fell through, thanks mainly to the Lightning's high price tag and the availability of significantly cheaper MiG-21s.



Above: In August 1962 No. 74 Sqn adopted black fins and spines.

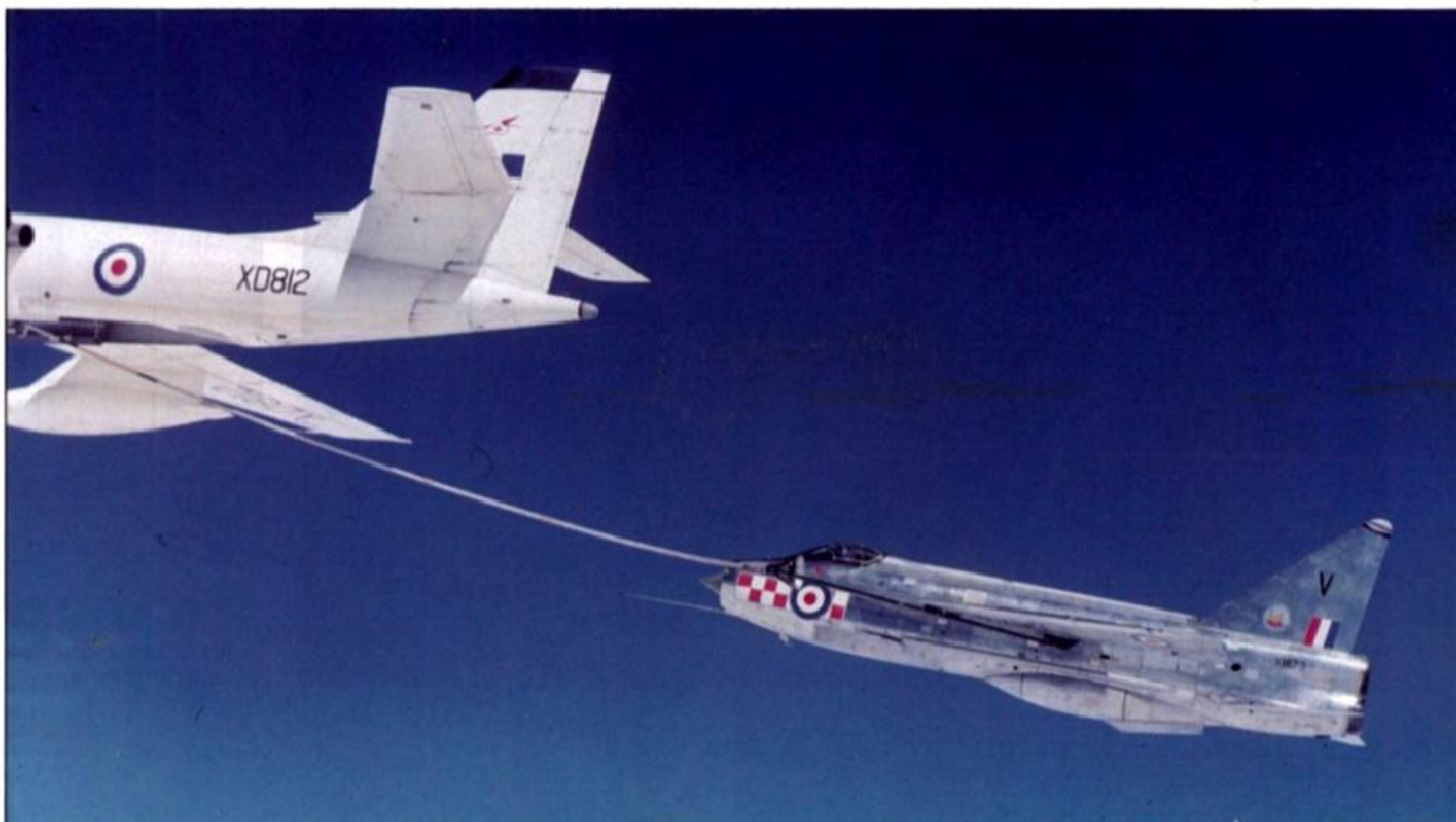
Left: A 'Tigers' F.Mk 1 at near-sonic speed displays the characteristic compression clouds which formed above the wings and just aft of the cockpit. For a while, 74's Lightnings operated without the ventral tank while a problem was fixed, effectively restricting the aircraft to sorties within the Coltishall overhead.

No. 56 Squadron was the first recipient of the F.Mk 1A, and pioneered the art of aerial refuelling. Here a squadron aircraft takes on fuel from a Valiant BK.Mk 1 from Marham-based No. 214 Squadron.

One reason that the Lightning's kit worked so well is that it was actually very primitive, even by the standards of the day. The Lightning was designed (and flown in prototype form) at much the same time as the US Convair F-102 Delta Dagger, and the two aircraft types present an interesting contrast. The Lightning had very much better performance in terms of speed, rate of climb and absolute ceiling,

F.Mk 1A

Compared to the F.Mk 1, the F.Mk 1A introduced several important features, the most obvious being the addition of an optional refuelling probe. This had been tested during 1959 by P.1B XA847, but the contacts were dry. The first F.Mk 1A, XM169, first flew on 16 August 1960, and it was this aircraft which was used for wet contact trials, initially receiving from Flight Refuelling Ltd's test Canberra B.Mk 2 WH734, and later from Valiant tankers. Other important changes were the replacement of the old VHF radios with UHF sets and the addition of external conduits along the sides of the central fuselage for wiring runs. These conduits had previously been incorporated into the engine bays.



F.Mk 1As at Wattisham

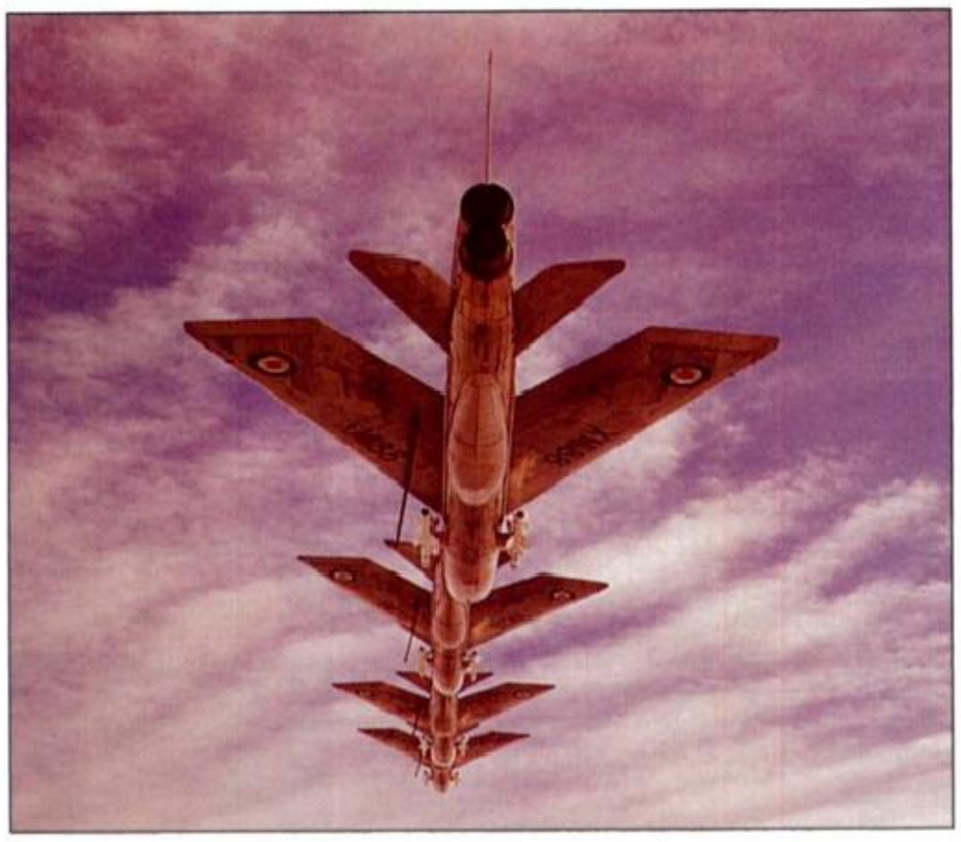
Beginning in January 1961 the RAF's second Lightning version began to arrive at Wattisham to equip Nos 56 and 111 Squadrons, along with a cadre of experienced pilots from No. 74 Sqn. The inflight-refuelling capability and UHF radios effectively made the F.Mk 1A the first truly operational variant, and the two squadrons were heavily tasked in wringing out the new type. Work-up for the units was protracted as aircraft were received only sporadically from the manufacturers, and a temporary move to Coltishall during runway repairs at Wattisham in 1961 did not help.

While at Wattisham both No. 56 Sqn (top) and No. 111 Sqn (above) introduced colourful markings on their F.Mk 1As.

The F.Mk 1As of 'Treble One' undertook high-altitude gun-firing tests in 1963. They employed the lower-gun weapon pack option; use of the upper guns was rare, as the muzzle flash tended to temporarily blind pilots.

and was considerably more agile. The Lightning pilot enjoyed a reasonable view from his cockpit, while the F-102 jock was buried inside a dark hole, forced to look through a V-shaped split windscreen and unable to see down over the long, inadequately drooped radome. The F-102 did have a low-drag internal weapons bay (bigger than the B-17's bomb bay) with six separate missile compartments to carry three IR-homing Falcons and three more with radar guidance, and with 24 2.75-in FFARs (Folding-Fin Aircraft Rockets) in the weapons bay doors. The F-102 lacked a gun, but with six AAMs probably had less need of one than the two-missile Lightning.

Most crucially, though, the F-102 was designed as a part of an integrated air defence system, with sensors and systems which would free it from reliance on a tail-chase, pursuit-type of intercept. To intercept somebody going across open country on foot, it is preferable to head them off by aiming towards their predicted position, rather than having to work around behind them and then run after them, following their footsteps. In other words, to use a collision course intercept. Until the Red Top missile was adopted on the Lightning F.Mk 3, the Lightning had no weapon capable of being used in a collision course intercept. Even with Red Top, the Lightning had no means of making an automatic intercept, whereas sophisticated interlinks between the F-102's own radar, ground control, the aircraft autopilot and the weapons computer could automatically fly the F-102 to the point in the sky at which a successful intercept was most likely, and then automatically fire the weapon. The F-102's radar could lock on to a



Above: A quartet of Firestreak-toting No. 111 F.Mk 1As displays the outward cant and mounting position of the refuelling probe. 'Treble One' tested the system's compatibility with Fleet Air Arm Sea Vixen tankers.

Far left: No. 56 Sqn was the first unit to refuel with the Lightning – this aircraft takes on fuel from the bomb-bay-mounted HDU of a Valiant BK.Mk 1. This tanker was used for the pioneering non-stop deployments to Akrotiri, the first of which was undertaken with two 'Firebirds' Lightnings on 23 July 1962. The journey was made in 4 hours 22 minutes.

Left: 'Treble One' also acquired refuelling proficiency in 1962, and undertook deployments to Cyprus and Malta. Later, the aircraft went to El Adem in Libya for ground-attack strafing trials.

target at 30-mile (48-km) range, and was augmented by a primitive but effective IRST (Infra-Red Search and Track) system. The F-102's Hughes MX-1179 fire control system made the Lightning's AI.23 look like something out of the Ark, and allowed the F-102 pilot to operate by day or night, in all weather, with a reasonable cockpit workload. In 1956, Convair flew the prototype F-106 Delta Dart, which added automatic interfacing with the Semi-Active Ground Environment radar and communications network. Twenty-five squadrons of F-102s were in service by 1958, and the F-106 was on the verge of front-line service by the time the Lightning F.Mk 1 entered service with the RAF.

Although the Lightning was primitive when compared to the Convair deltas, the aircraft was very much more versatile, and was far more capable in fighter-versus-fighter combat. Moreover, the Lightning was considerably more capable than its European rivals, on both sides of the Iron Curtain.

Improved model

Only the first 19 full production Lightnings were built as F.Mk 1s, XM169 and 27 subsequent aircraft being delivered as F.Mk 1As. They had UHF radio from the start, improved windscreen rain dispersion, provision for a detachable inflight-refuelling probe below the port wing-root, and external cable ducts leading forward to the missile pylons. The F.Mk 1A weighed in at 25,737 lb (11675 km) (26 lb/12 kg lighter than the F.Mk 1) and was powered by the Avon Mk 210R with a revised four-position reheat control. These aircraft equipped two squadrons at RAF Wattisham, No. 56 being the first to receive a Lightning, on 14 December 1960, followed by No. 111 Squadron from March 1961. By the time the two squadrons stood up, it was clear that their new aircraft would be no more than interim equipment, with further developments of the Lightning apparently just around the corner. Even the F.Mk 2, on order but yet to fly, would not be the ultimate Lightning.

As early as 1960, it had become apparent that the advances in SAM technology expected and forecast by the 1957 White Paper were entirely illusory, and that manned aircraft were still very much the only future for air operations. Those projects which had escaped cancellation in 1957 were pressing ahead, with TSR.2 seeming to be a potential Canberra replacement, and with the Mark Two V-Bombers entering service. That year the RAF established its case for a 'Second Generation Lightning' to supplement and then replace its early model Lightnings, on the grounds that it was "unwise to predict ... when manned fighters will finally go out of use."

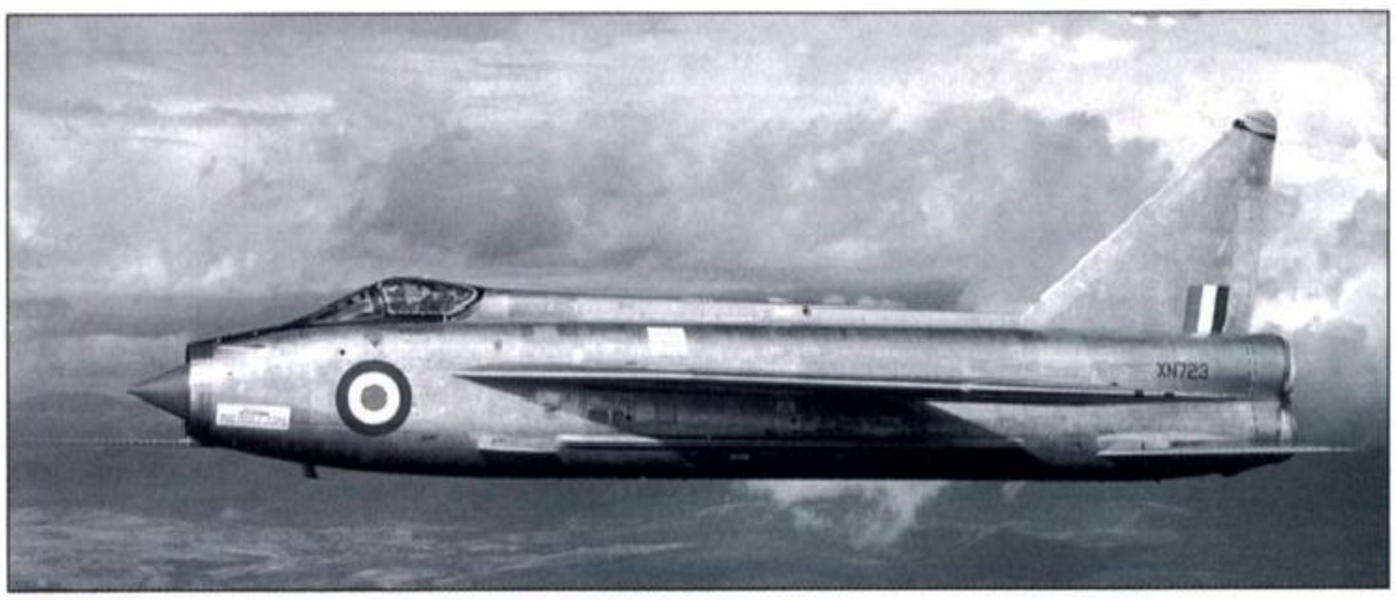
When ordered in 1958, the Lightning F.Mk 2 with its Avon Mk 210 engines, LOX system and revised integrated instrument panel marked enough of an improvement over the F.Mk 1 to be considered a worthwhile insurance policy in the event that the new SAMs were delayed, but everyone was convinced that the Lightning F.Mk 2 would be the end of the line for the manned fighter, let alone the Lightning. The new instrument system processed inputs from the master reference gyro and the air data controller, and provided a navigation display which could give a compass, ILS, UHF homer or TACAN readout. There was

F.Mk 2

Similar to the F.Mk 1A, the F.Mk 2 introduced a number of improvements. They included fully-variable reheat, liquid oxygen system instead of gaseous, improved navigation equipment, OR.946 instrument panel, automatic flight control and a stand-by DC generator.

Clearly visible on this probeless No. 56 Sqn aircraft is the fuselage-side cable conduit introduced by the F.Mk 1A. It placed vital electrical wiring runs outside of the dangerous engine bay area.

XN723 was the first F.Mk 2, flying for the first time on 11 July 1961. The only external difference between it and the F.Mk 1A was the small inlet mid-way along the spine for the stand-by generator.



Above: The LCS and early 226 OCU had no special markings for its aircraft other than using the last-three of the aircraft's serial (and yellow 'T-bands' for the T.Mk 4s). In August 1963 the unit adopted the shadow unit markings of No. 145 Squadron. The first version was this spectacular red and white scheme.

Right: In common with the other Lightning users, 226 OCU had to tone down its markings in 1966, resulting in this scheme with regulation-size nose bars and fin badge. The last-three were retained throughout the unit's existence.

The Schoolhouse

When Lightning training first officially began in January 1960, the Lightning Conversion Squadron had to borrow aircraft but, in June 1962, the first of its allocated T.Mk 4s arrived. At this time the LCS was based at Middleton St George, at which base the unit officially became 226 OCU on 1 June 1963. In addition to the T.Mk 4s, F.Mk 1s (from No. 74 Sqn) were also acquired, giving way to ex-Nos 56 and 111 Sqn F.Mk 1As in 1965. Unit strength increased to about 36 aircraft by the end of the 1970s.

provision for a datalink readout, too, but this equipment was never fitted. The radar B-scope could present a course to steer manually, and could also present programmed climb, altitude and heading hold, plus ILS track and glide information. A course could be flown automatically by the autopilot.

The first F.Mk 2 made its initial flight on 11 July 1961. The delayed delivery of the new OR.946 integrated flight control and instrument system meant that aircraft were completed to an interim standard at Samlesbury, and were then flown to Warton where they were stripped down and rebuilt to the full intended production standard. The non-availability of OR.946 had previously led to the F.Mk 1 and F.Mk 1A being delivered with a more austere instrument fit, but, in waiting for deliveries, the F.Mk 2 was subject to a considerable delay. It was thus 14 November 1962 before XN771 became the RAF's first F.Mk 2, going to the AFDS at Binbrook. On 17 December the variant entered service with No. 19 Squadron at Leconfield, where Nos 19 and 92 Squadrons had been using a quartet of new two-seat T.Mk 4s for training. By then things had moved on, and the F.Mk 2 was itself no more than an interim Lightning, pending introduction of the 'ultimate' F.Mk 3.

Apart from the new instrument system, the F.Mk 2's most significant feature was the introduction of fully variable reheat. Although the engine produced slightly less thrust than the later 300 series Avons, its 'spark plug' reheat system was considerably less temperamental, and the match between intake and engine was better, making the F.Mk 2 many pilots' favourite. Externally, the F.Mk 2 could be distinguished from the F.Mk 1A by a small intake on the spine, which served the stand-by generator.

According to many, the F.Mk 2 was the best of the Lightning variants to fly. It retained the clean fuselage lines and 'witch's hat' fin of the F.Mk 1, but introduced fully-variable reheat and a number of pilot-friendly features such as a new cockpit layout and automatic flight control system. This example is from No. 19 Sqn at Leconfield.

Enter the 'Tub'

By the time the F.Mk 2 arrived, conversion training for new Lightning pilots had become less stressful with the introduction of the T.Mk 4 trainer. Design of a two-seat Lightning had been initiated during 1957, and the prototype, XL628, had flown as the P.11 on 6 May 1959. The prototype was almost identical to the P.1B aft of its side-by-side two-seat cockpit, and lacked provision for the two cannon atop the nose. It was otherwise fully operationally capable. The aircraft was lost on 1 October, but was immediately replaced by a second prototype on 21 October. Twenty production two-seaters based on the F.Mk 1A were delivered to the RAF as Lightning T.Mk 4s, the first going to the Lightning Conversion Squadron (by then at Middleton St George) on 27 June 1962. Most of the T.Mk 4s were delivered to the LCS and its successor, No. 226 OCU, although others went to the front-line squadrons flying F.Mk 1s, F.Mk 1As and F.Mk 2s.

The early Lightning single-seaters were all armed with a pair of cannon in the top of the nose (with provision for another pair below the nose, in place of the Firestreaks), but they were not regarded as very useful as air-to-air weapons in the missile age. Accordingly, the cannon ports were rapidly faired over to reduce drag, a modification that was usually undertaken at squadron or station level. Only the F.Mk 2s destined for service in RAF Germany left their cannon ports unfaired as a matter of course, since it was anticipated that these machines would fulfil a secondary ground attack role. On other squadrons, air-to-ground gunnery was practised (albeit infrequently), often using cannon in the undernose position, with the guns replacing the usual Firestreak missile installation. Treble One used these lower cannon for high-speed, high-altitude air-to-air

English Electric Lightning F.Mk 2 No. 92 Squadron RAF Leconfield

As the ultimate expression of the first-generation Lightnings, the F.Mk 2 was an important stepping-stone to the introduction of the 'definitive' F.Mk 3. The sweet-handling Mk 2s were issued to Nos 19 and 92 Squadrons, who took their aircraft to Germany. Here they were highly valued for their low-level handling and stability as gun platforms, two attributes which made them suitable for the type of threat they faced on the Central Front.

Cannon
The F.Mk 2 retained the upper pair of 30-mm ADENs as well as the lower-gun option. Each weapon was armed with 130 rounds.

Fuel system
The majority of the Lightning's fuel was held in the wing tanks, which fed by gravity, air pressure or electric pumps into a wing collector box on each side of the aircraft. Each had booster pumps to feed the fuel to the engine. The small ventral tank held 2,000 lb (907 kg) and could be jettisoned in the air (unlike the larger tank of the F.Mk 2A/6).

Brake chute
Certified for use up to 200 kt (370 km/h; 230 mph), the brake chute was seen as the primary means of stopping the Lightning. It was attached just above the top engine's tailpipe, but was housed in the scallop between the engines on the port side.

Steering
Ground steering was by differential braking only, the nosewheel being free to castor up to 30° either side. A nosewheel aligning system was fitted to straighten the wheel for landing.

Individual aircraft
XN733 first flew on 1 February 1961, but owing to the difficulties experienced with the F.Mk 2, which saw aircraft built to an interim standard and then stored pending further work, was not delivered to No. 92 Sqn until 6 June 1963. It was later converted to F.Mk 2A standard, and ended its days as a decoy at Laarbruch.

Radar
F.Mk 2s were equipped with the original AI.23 AIRPASS equipment, optimised for tail-chase intercepts. Such tactics were preferred to the collision-course intercept as it gave the pilot more time to sort out the geometry and also allowed the Lightning to press in for a guns attack if the missile failed.

Navigation system
TACAN was the primary system, incorporating an offset function and a reciprocal heading 'get-you-home' function. Augmenting this was a homing facility on the VHF radio, and an ILS system.

No. 19 Sqn (above) never adopted the bright colours of its contemporaries. On the other hand, its partner, No. 92 (below), escaped the 1966 toning-down ruling as it was part of RAF Germany rather than Fighter Command.

Above: A hangar scene at Leconfield shows F.Mk 2s from both squadrons undergoing deep maintenance. The engine bay hatches are fully removed, illustrating how the two engines could be removed and replaced in a matter of hours. Leconfield was the centre of Lightning maintenance work (with 60 MU) for much of the aircraft's career.

Above right: Both Nos 19 and 92 Sqns had to make do with T.Mk 4 trainers in the initial part of their transition to the Lightning, as the F.Mk 2s were not available. The Mk 4 was retained to the end of Lightning operations in Germany as its equipment fit equated to that of the F.Mk 2/2A.

Leconfield wing

Third operational base to receive the Lightning, Leconfield was chosen as the centre for F.Mk 2 operations. No. 19 Sqn took its place in the UK air defence line-up in 1963, followed soon after by No. 92. In 1963 No. 19 sent a discreet three-aircraft detachment to Saudi Arabia for RSAF evaluation of the Lightning. In early 1965 both squadrons began operating in the four-gun configuration, flying ground-strafing exercises in preparation for their move to Germany, where ground attack would be specified as a secondary mission.

gunnery trials in 1963, then again for air-to-ground firing on the range at El Adem, in Libya. During this deployment the squadron also practised using the 2-in rocket pack installed in the same position.

The actual production Lightning's restricted endurance and range meant that inflight refuelling was accorded a very high priority. Without it, for example, QRA (Quick Reaction Alert, originally known by the name Interceptor Alert Force) was of little real meaning, since the Lightning could not intercept Soviet reconnaissance aircraft or bombers until they were perilously close to the coast. No. 56 Squadron's F.Mk 1As were the first Lightnings equipped for inflight refuelling, and after trials in the UK with Valiant tankers the squadron flew non-stop to Cyprus in July 1962. No. 19 Squadron practised inflight refuelling from the Valiants in January 1964, prior to a short deployment by three aircraft to Saudi Arabia. Unfortunately, the premature withdrawal of the Valiant left a hiatus, although No. 111 Squadron had also practised refuelling from buddy pod-equipped Sea Vixen FAW.Mk 2s. When the Victor K.Mk 1s were introduced, No. 19 Squadron's F.Mk 2s carried out refuelling trials with the new tanker type.

Air show displays

The F.Mk 1 and F.Mk 1A were destined to have brief but glorious front-line careers. No. 74 Squadron 'Tigers' handed the Fighter Command aerobatic display team commitment to the 'Firebirds' of No. 56, having displayed their sleek new aircraft at the Paris Air Salon, the Farnborough air show and several Battle of Britain displays in 1961, and more air shows in 1962, by which time the aircraft had gained black fins and spines, heralding a new era of highly colourful squadron markings for the type. The 'Firebirds' flew for only a single season (displaying at a handful of shows), their aircraft gorgeously decorated with red fins, spines and leading edges, and with lead ballast replacing their AI.23 radars.

While Nos 74 and 111 Squadrons won public acclaim with their aerobatic displays, No. 111 Squadron's F.Mk 1As achieved some important milestones. A visit to Gütersloh in Germany presaged the later basing of Lightnings within RAF Germany, and the squadron also carried out air-to-ground firing at El Adem with the lower ADEN guns and the 2-in rocket packs.

Although No. 74 Squadron moved to Leuchars in January 1964, and discarded the F.Mk 1 between April and June 1964, the type's career was not quite over, even in the front

Left: This No. 19 Sqn F.Mk 2 carries Firestreaks, but has the lower cannon ports left open.

Below: No. 92 was chosen as the Fighter Command aerobatic display team for the 1964 season.

Display teams

Crisp handling, a surfeit of power and good stability made the Lightning an ideal formation aerobatics aircraft from the pilot's point of view, but it was the sleek shape, blistering acceleration and, above all, the deafening noise which made it a firm crowd favourite. The four Lightning display teams used the aircraft's power to the full, starting with stream take-offs before a display which involved many vertical manoeuvres.

Command display teams to use Lightnings also used successive variants. At top left are the F.Mk 1s (1962) of No. 74 Sqn, which were followed by the 'Firebirds' of No. 56 Sqn (left), the best-known of the Lightning teams. Although they carried Firestreaks during the display, the aircraft lacked radars. Shown above is a shot from within the nine-ship formation as it pulls through a loop. The 'Firebirds' blotted their copybook in June 1963 when two aircraft collided during a practice at Wattisham. One aircraft managed to land, but the pilot of the other sustained serious injuries during ejection. Following the 'Firebirds' were the F.Mk 2s (1964) of No. 92 Sqn. They are seen (above left) with the Hunters which had been used for an earlier season during which the 92 team used the name 'Blue Diamonds'. In 1965, the final year in which Fighter Command put up an official team, the laurels were worn by No. 111 Squadron with its F.Mk 3s.

line. Three OCU F.Mk 1s were loaned to No. 111 Squadron in September 1964 to cover for a shortage of F.Mk 1As, two of the aircraft (XM140 'Romeo' and XM146 'Juliet') remaining with the unit until February 1965, gaining full squadron markings. They were not flown much, however, being relegated to QRA (with the earnest hope that they would not be scrambled, since they lacked inflight-refuelling probes.). The F.Mk 1's more rudimentary reheat system and different throttles meant that only certain No. 111 Squadron pilots were cleared to fly them.

The F.Mk 1A lasted little longer than the F.Mk 1s in the front line. No. 56 Squadron re-equipped in early 1965, receiving its first F.Mk 3s in March; No. 111 received its first F.Mk 3 on 7 November 1964, and had reached its full complement by 10 February 1965. Despite the F.Mk 1 and F.Mk 1A having brief front-line service careers, the airframes were destined to serve on another 10 years in second-line roles, with newly formed target facilities flights and with the Lightning OCU, No. 226, at RAF Coltishall. The F.Mk 2 was destined to last even longer than the Mk 1 and 1A, although its longevity was largely the result of a major rebuild programme, described later in this narrative.

The Lightning F.Mk 3 (regarded at its inception as the definitive, ultimate Lightning) marked, in truth, a very modest improvement over the basic Lightnings it replaced in service. This was a shame, since English Electric would have been more than happy to provide the RAF with an aircraft with all the improvements of the F.Mk 3, which would also have had a better range and endurance (with the big belly tank first flown on a P.1B in 1960), probably with a neat retractable refuelling probe, and with the more efficient cambered wing flown on the first P.1A in 1957. English Electric went to the trouble of designing, developing and clearing jettisonable overwing fuel tanks for the F.Mk 3, but the RAF failed to order them, or the auto attack system developed by Ferranti, Elliott and English Electric.

Manual intercept

The failure to fit the auto attack system (and datalink) to production Lightnings was inexplicable. The system was successfully trialled in P.1B XG328, and proved simple to use, and a great improvement over manual control in supersonic collision course intercepts, when pilots would intuitively wait too long to turn. The development of the system was successfully completed (at a cost of £1.4 million), and yet was never adopted. Nor was the Light-

T.Mk 4 trainer

With the company designation P.11, the T.Mk 4 trainer made its first flight on 6 May 1959, although this prototype was lost on 1 October, gaining the dubious distinction of being the first Lightning to crash. The trainer lacked gun armament but had radar and full Firestreak capability.

Top right: The T.Mk 4 prototype is seen during an early test flight. In the course of general handling trials the 'T-bird' demonstrated much lighter stick forces than the single-seaters.

Above: Shortly before its demise, the first T.Mk 4 received this titling for its appearance at the 1959 Farnborough air show.

ning's programmed climb facility, which allowed a hands-off climb to height in which the autopilot kept airspeed to 250 kt (287 mph; 460 km/h) until this equated to Mach 0.9, which meant a very steep and rapid climb. The procedure was to take off, select wheels up, and select programmed climb. If the chosen heading was not the runway direction, the aircraft would automatically turn to the heading (at 250 kt and 60° angle of bank) and into the climb. The angle of bank was subsequently reduced to 45° and the speed was increased, to improve pilot confidence, but in the end the system was not fitted to operational aircraft.

The company could even offer a Lightning with variable-geometry wings, or a true multi-role fighter-bomber and reconnaissance-capable sub-variant. It was made clear that an advanced Lightning could include look-down radar, inertial navigation equipment, semi-recessed low-drag missile carriage, longer-range semi-active radar homing missiles, and an IRST. A need existed for an advanced Lightning, but the government was unwilling to pour money into an interim fighter that was destined for replacement by aircraft like the Hawker P.1154.

As a result, the F.Mk 3 received by the RAF was little more than a refined F.Mk 2, stripped of its guns and compatible with the Red Top missile. Since so little use was made of guns by the early single-seat Lightning variants, there should have been little surprise that the Lightning F.Mk 3 had no provision for cannon whatever. The new variant was the first to be compatible with the new Red Top missile, originally developed as the Firestreak Mk IV. Externally, the Red Top had a new seeker head fairing, with a single glazed dome replacing the faceted glazed panels of the basic Firestreak. It also had reconfigured control surfaces, with the forward fins being of reduced leading-edge sweep and of trapezoidal planform. Internally, the Red Top had a larger 68-lb (30-kg) warhead and a new, more sensitive seeker head which gave much improved all-aspect capability. The rocket motor was improved, increasing speed beyond Mach 3 and range beyond 7 miles (11 km).

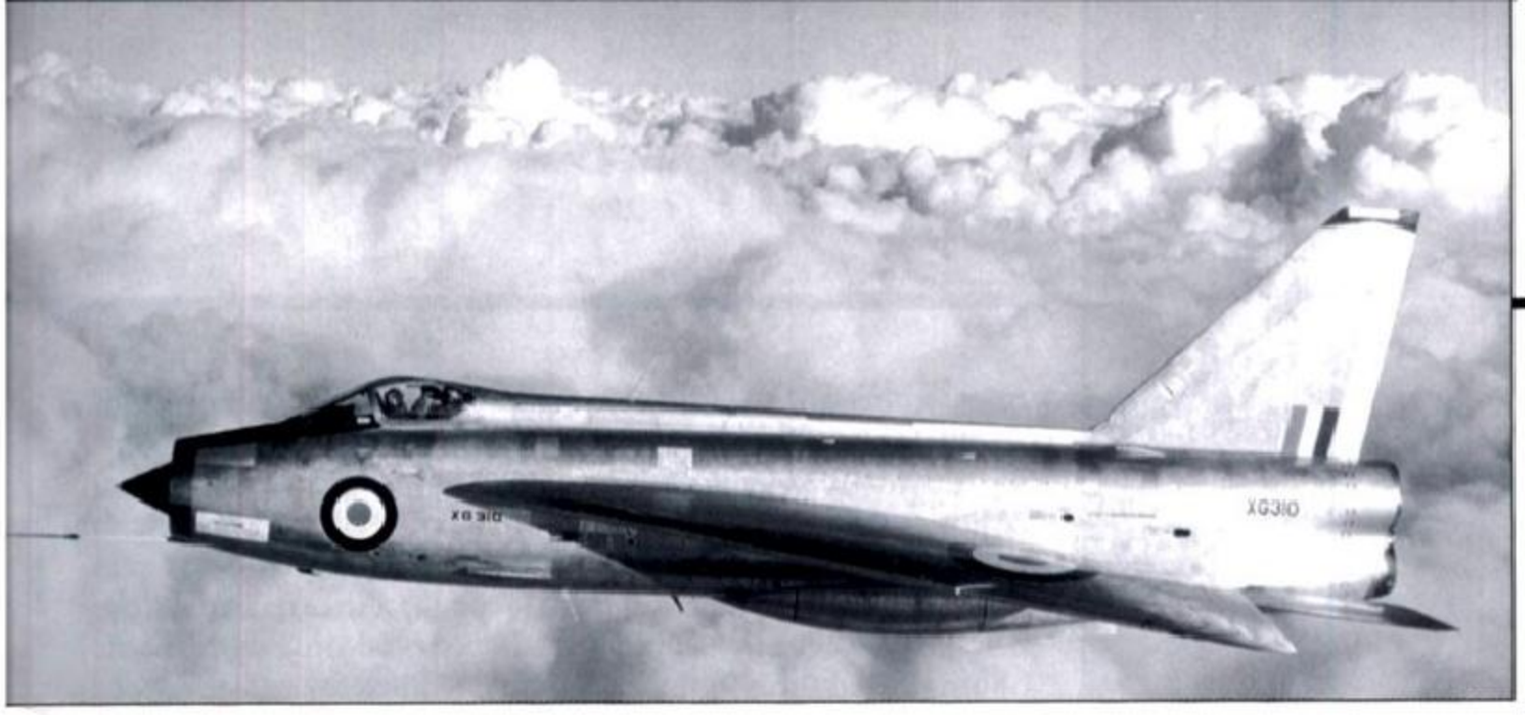
Square fin

Visually, the Lightning F.Mk 3 was immediately identifiable by the addition of an enlarged tailfin. This had 15 per cent greater area, and a square-cut tip that was quite different to the pointed 'witch's hat' shape of previous versions. Arguably the most significant feature of the F.Mk 3 was its Avon Mk 301 (RB.146) engines, which developed more thrust than previous Avons and which, more significantly, had a more flexible reheat system. The new engine proved to be a joy to fighter pilots, practically impossible to surge, and tolerant of throttle slamming and disturbed airflow in the intake. In practical terms, this meant that a Lightning pilot could accelerate to Mach 2, slam the throttles to idle and pull a 5-*g* turn in complete confidence – something that was impossible in US fighters until the F-15 and F-16.

Seventy Lightning F.Mk 3s were built, re-equipping the F.Mk 1 and F.Mk 1A squadrons and allowing the formation of another unit, No. 23 Squadron. This left Nos 74 and 23 Squadrons at RAF Leuchars, with Nos 56 and 111 Squadrons at RAF Wattisham, and with the F.Mk 2s serving with Nos 19 and 92 Squadrons at RAF Leconfield. The introduction at Leuchars of the F.Mk 3, with its

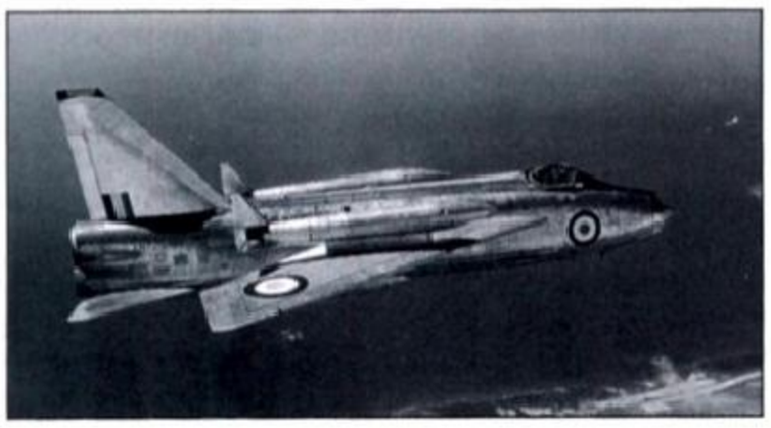
Above: After XL628 was lost, the second prototype performed the bulk of development work. It later passed to the Empire Test Pilots' School.

Right: The bulk of the T.Mk 4s served with 226 OCU, operating in a variety of colours but latterly in those of No. 65 Sqn, shown here. Others were assigned in small numbers to the front-line units to act as continuation trainers and for check rides.



F.Mk 3

Viewed as the second-generation Lightning, the F.Mk 3 featured considerable improvements. They included AI.23B radar with ECCM, Red Top missiles, new cockpit display, extra internal fuel, wings stressed for overwing tanks, uprated Avon Mk 301 engines and a squared-off fin that was 15 per cent larger than on previous models. XG310 (left) served as the prototype, first flying as such on 16 June 1962.



XN725 was one of two F.Mk 2 airframes assigned to F.Mk 3 development work. It first flew on 31 March 1962, and was used to test the overwing tanks, here fitted with small fins.

The tank fins were found to be unnecessary and were soon deleted. Seen here is the other F.Mk 2 development aircraft, which made its first Avon Mk 301-powered flight on 13 July 1962.

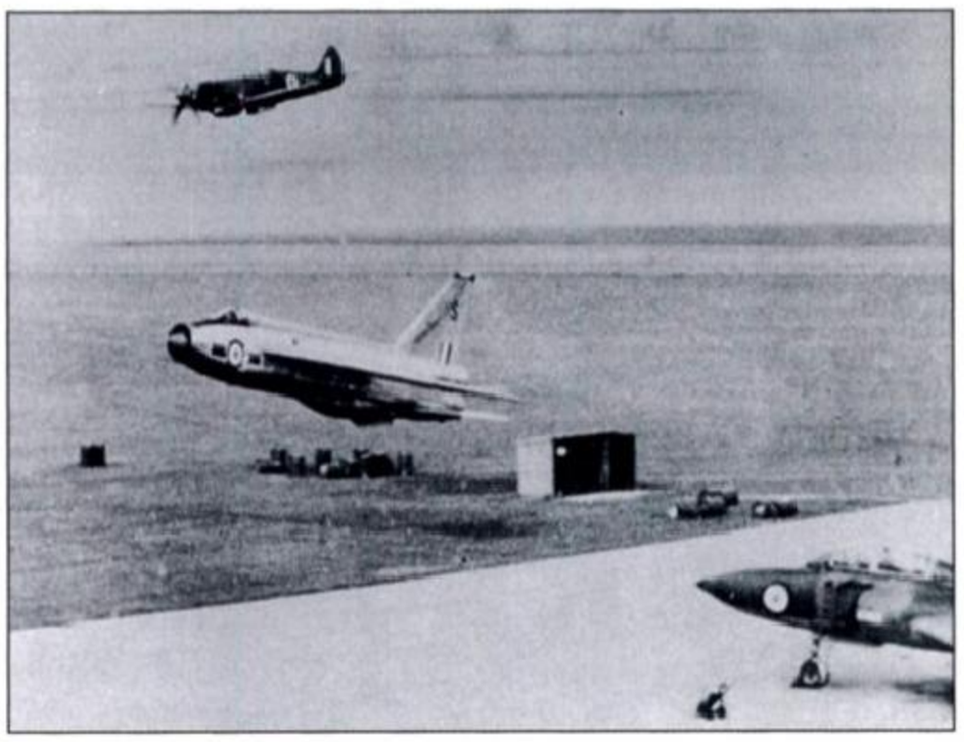
XP694 was the second F.Mk 3 to be built as such. It was retained for AI.23B radar development work, exploring the collision-course intercept tactics made possible by the radar and Red Top.

standard fit of an inflight-refuelling probe, made QRAs a common event as Lightnings scrambled (with tanker support) to intercept Soviet reconnaissance, bomber and patrol aircraft far out over the North Sea. When the Valiant tankers were prematurely retired, pending the introduction of the Victor B(K).Mk 1A in May 1965, the Lightnings operated with the support of hastily adapted USAF Boeing KC-135 tankers. The introduction of the F.Mk 3 was also accompanied by increased efforts to sell the aircraft abroad, supported by overseas deployments by UK-based squadrons. In the late summer of 1965, No. 74 Squadron deployed to the Middle East, where the unit visited Iran and conducted a flypast for the Shah.

Extended range

When production switched to the Lightning F.Mk 6, the RAF again received an aircraft which was an improvement over previous variants, but also one which represented only a fraction of what was possible. Originally designated F.Mk 3A or F.Mk 3 ERV (Extended Range Version – a more honest description), the new variant finally introduced the enlarged ventral tank and cambered wing which could have been available on the F.Mk 1, and the fuel-filled flaps, and the overwing fuel tanks. It still lacked nosewheel steering or an auto attack system (both developed, tested and cleared years before), and still had no INS and no long-range missile, relying instead on the increasingly laughable armament of only two short-range IR-homing weapons. Development of the long-range F.Mk 3A began in 1963, with an F.Mk 3 (XP697) and an F.Mk 2 (XN725) allocated to the programme for development work.

The new, enlarged ventral tank was slightly refined by comparison with the tank flown on the two P.1Bs many



In 1963 Britain found itself facing the Indonesian air force in the colonial conflict in Borneo. Indonesia's Mustangs were to prove elusive intercept targets for the Javelins then in-theatre, so the Air Fighting Development School at Binbrook borrowed a Spitfire PR.Mk 19 to evolve anti-Mustang tactics for both the Javelin and Lightning. Here one of the AFDS F.Mk 3s makes a low pass in front of the tower with the Spitfire behind and a No. 64 Sqn Javelin on the ramp.

When No. 56 Squadron moved to Cyprus in 1967, it became the only unit to take the F.Mk 3 overseas for a long-term deployment. Once at Akrotiri, the squadron quickly absorbed the three target facilities Canberra B.Mk 2s stationed there. One of these aircraft can be seen in full 'Fifty-Six' insignia, behind this Firestreak-armed F.Mk 3.

As befitted the first operational squadron, No. 74 was also the first recipient of the missile-only F.Mk 3 (and later the full-standard F.Mk 6). It received its first aircraft in April 1964 and belatedly began learning the art of aerial refuelling. Its career with the F.Mk 3 was brief.

Above: No. 111 converted from the F.Mk 1A to the F.Mk 3 in the winter of 1964/65. This pair illustrates the differences between the two variants.

Right: No. 29 Squadron came late to the Lightning, and only flew the F.Mk 3.

Above: A 'Tigers' F.Mk 3 taxis from a rain-soaked Wattisham ramp. Among other systems changes, the external conduit was extended forwards on the Mk 3, precluding the fitment of the twin-gun weapon pack.

Below: A new squadron, No. 23, was formed to partner No. 74 (below right) within the Leuchars Wing.

years before. It was built in three sections, and could contain up to 4,880 lb (2210 kg) of fuel, more than double the capacity of the original ventral tank. The front section could be replaced by a reinforced compartment containing two 30-mm ADEN cannon, with ammunition, feed mechanisms and all necessary vents and inlets. With guns installed, the capacity of the ventral tank fell to 4,280 lb (1940 kg). Work on a multi-role version of the Lightning began in earnest in 1964, and could have been applied to the new F.Mk 3A.

English Electric also proposed that the forward part of the tank and the missile pack could be replaced with reconnaissance equipment. Eventually, a compact, rotating, air-conditioned and demisted reconnaissance pack containing up to five Type 360 70-mm Vinten cameras (forward oblique, port and starboard oblique, and split vertical) with lenses of between 1.75 in and 6 in focal length was designed to replace the missile pack. Alternatively, the missile pack could be replaced by two 'drop-down' packs of unguided spin-stabilised 2-in rockets for air-to-air or air-to-ground use. The company had already designed a ventral 'combat pack' for the Lightning (fitted in mock-up form to F.Mk 2 XN725, during F.Mk 3 development), with two pylons for bombs or air-to-ground missiles (dummy Bullpups were fitted at one stage). Provision was made for the carriage of weapons on the overwing fuel tank pylons, and on newly developed underwing pylons outboard of the undercarriage. English Electric then proposed a combined fuel tank/rocket pod, with a 19-round SNEB-type pod on the front of a cylindrical fuel tank, two of which could be installed on each overwing pylon.

Single-role operation

The RAF therefore could have had a fully multi-role F.Mk 6 (like the F.Mk 53s delivered to Saudi Arabia and Kuwait) at very little extra cost, but this option was never seriously considered. The RAF has never been open to true multi-role operation of its aircraft, even when the platform has been multi-role capable. There should have been nothing to prevent Lightning pilots being fully competent in the day ground-attack role without in any way compromising their effectiveness and efficiency in the primary air-to-air role, but the RAF did not (or could not) see this. They needed a pure-and-simple interceptor for Fighter Command, and the possibility of Fighter Command squadrons having the same (or better) ground attack capability as the No. 38 Group Hunter units held little appeal. This was short-sighted, since the Lightning was destined to have an important role with squadrons based outside the UK, in Germany, Cyprus and Singapore, where multi-role capabilities would have been invaluable. Perhaps it was felt that the aircrew were incapable of being adequately trained in both roles. Much the same kind of decision is being made today, with the multi-role Eurofighter being planned to be issued mainly to single-role squadrons.

While English Electric built single-role Lightning F.Mk 6s for the RAF, it was also developing a very similar – but multi-role – version for sale to Saudi Arabia and Kuwait. Rather than prompting an RAF change of heart, since a multi-role Lightning was being developed anyway, English Electric even had to pay for the use of air-to-ground weapons ranges. So, far from receiving a multi-role Lightning F.Mk 6, the RAF actually took delivery of aircraft which were little more than F.Mk 3s with a new wing and increased fuel capacity, since they were initially delivered without guns, let alone any more exotic armament. The two F.Mk 6 prototypes (XP693 and XP697) had both been built as F.Mk 3s, the second flying to Filton on its second

Leuchars F.Mk 3s

Leuchars was chosen as the first base for the F.Mk 3. During the early F.Mk 3 period, in the wake of the hasty and premature retirement of the Valiant, the Leuchars-based squadrons had to rely on tanker support from drogue-equipped USAF KC-135As until sufficient Victors were modified. Soviet activity began to increase during the mid-1960s, and Leuchars rapidly became the busiest Lightning base in terms of operational scrambles.

flight for conversion to F.Mk 3A standards. Even the first production examples of the new variant had begun life on the production line as F.Mk 3s, being modified with the new wing and ventral tank before delivery. These aircraft (XR752-XR767) were designated F.Mk 3A or F.Mk 6 (Interim) and were not compatible with the overwing tanks, though they were subsequently brought up to full F.Mk 6 standards during 1967 and 1968. The first F.Mk 6 (Interim) made its maiden flight on 16 June 1965, in the hands of Jimmy Dell.

The Interim F.Mk 6s were delivered to the AFDS and Handling Squadron, but also equipped the first F.Mk 6 front-line unit, No. 5 Squadron. A handful subsequently went to No. 23 Squadron. The 16 F.Mk 6 (Interim) aircraft were joined by seven aircraft (XR723-728 and XR747) which first flew as F.Mk 3s during February-April 1965, but which were delivered straight to Warton for storage prior to conversion to full F.Mk 6 standards between June and November 1967. The RAF also received 39 aircraft (XR768-773, XS893-904, XS918-938) which were built and delivered as full-standard F.Mk 6s, capable of carrying the overwing fuel tanks. They each contained 2,380 lb (1080 kg) of fuel, increasing capacity to nearly 15,000 lb (6800 kg).

Heavyweight fighter

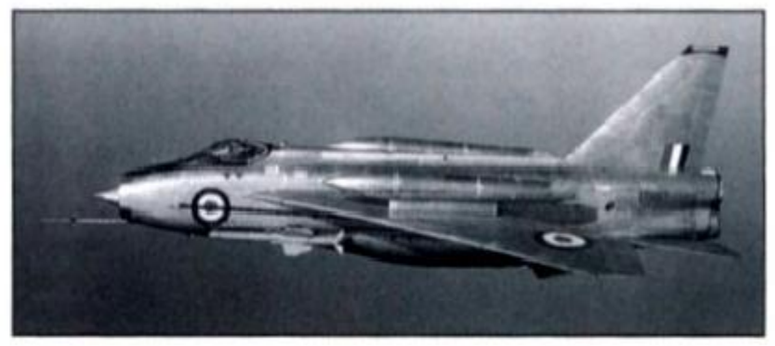
The F.Mk 6 was 1,100 lb (500 kg) heavier than the empty F.Mk 3, and 2,300 lb (1045 kg) heavier than the F.Mk 1, but it carried 3,100 lb (1400 kg) more internal fuel (without the overwing tanks) and had a maximum take-off weight of 41,700 lb (18900 kg). This led to the adoption of standard operating procedures for the F.Mk 6 which mandated the use of afterburner on take-off. The same procedures were subsequently adopted by the heavyweight F.Mk 2A and the T.Mk 5 trainer.

English Electric (or BAC, as it by then was) had reasonable expectations of being able to sell a multi-role Lightning based on the F.Mk 6 to a number of foreign air forces, targeting Australia, Austria, Brazil, Germany, Japan, Nicaragua, Singapore and Venezuela in particular. As a nationalised concern, BAC did not have sufficient private funds to invest in development of an export aircraft, and with no RAF order the development of the multi-role capabilities of the aircraft was painfully slow. Had it been available earlier, the Lightning might have competed effectively against the Mirage III in some markets, although the single-engined French machine was inevitably cheaper than the British twin.

In the end, the Lightning fought off competition from Dassault and US manufacturers to win its first order from the Kingdom of Saudi Arabia. The sales campaign was

F.Mk 3A

Also known as the Interim F.Mk 6, the F.Mk 3A was based on the F.Mk 3 but introduced a much larger ventral tank, based on the weapons pack studied earlier and mocked-up on a P.1B. In addition, the variable-camber wing first tested on a P.1A was adopted, this providing a useful decrease in subsonic drag and landing speed.



Top: XR754 was one of the batch of F.Mk 3As built with the big tank and kinked wings but without the full F.Mk 6 systems.

Above and above left: Two views show XP697, which was the first F.Mk 3A to fly, on 17 April 1964. It had been preceded by a modified F.Mk 2 (XN725) with just the new leading edges.

Above: A trio of Red Top-armed F.Mk 3s executes a break. The new missile proved unreliable at first, and many F.Mk 3s retained the Firestreak.

Above left: Three F.Mk 3s from No. 111 Sqn are seen at Luqa. The Maltese base was a regular destination for Lightning squadrons.

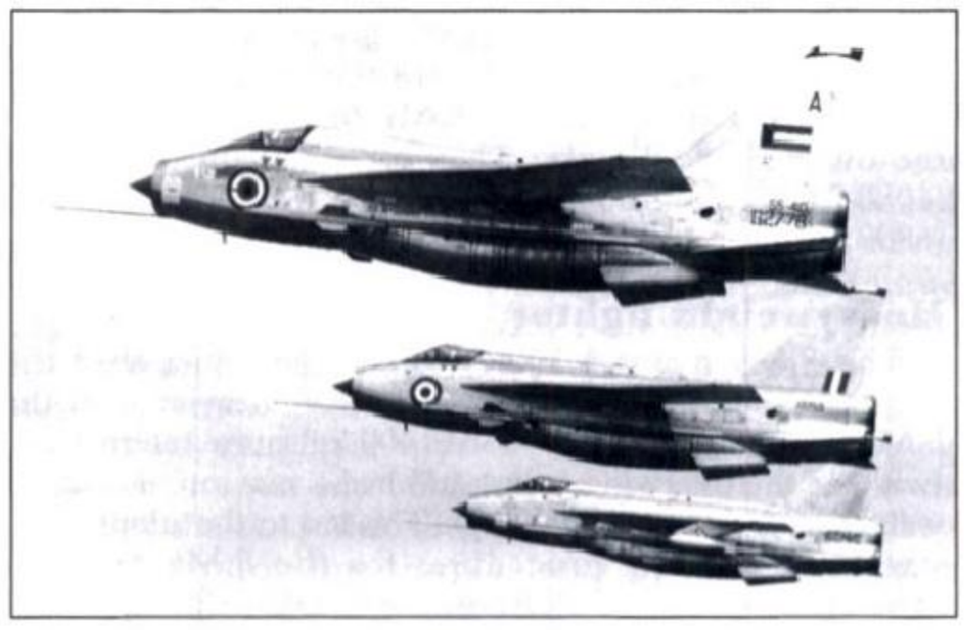
Left: When Nos 23, 56 and 74 Sqns converted to the F.Mk 6, sufficient F.Mk 3s became available to form No. 29 Squadron, which replaced No. 56 in the Wattisham roster.

BAC export drive

Having been deflected from earlier studies by the pressing needs of the RAF, the Lightning design team renewed its efforts to produce a multi-role aircraft for export in 1964, although by then most of the potential customers had already bought Mirage IIIs or F-104s. However, the work bore fruit on 21 December 1965, when Saudi Arabia announced its order for the Lightning. An intense marketing effort to gain other customers followed, although only Kuwait was interested enough to buy.

Above: For the 1966 Farnborough show an RAF F.Mk 6, XR770, was painted up in full Saudi colours.

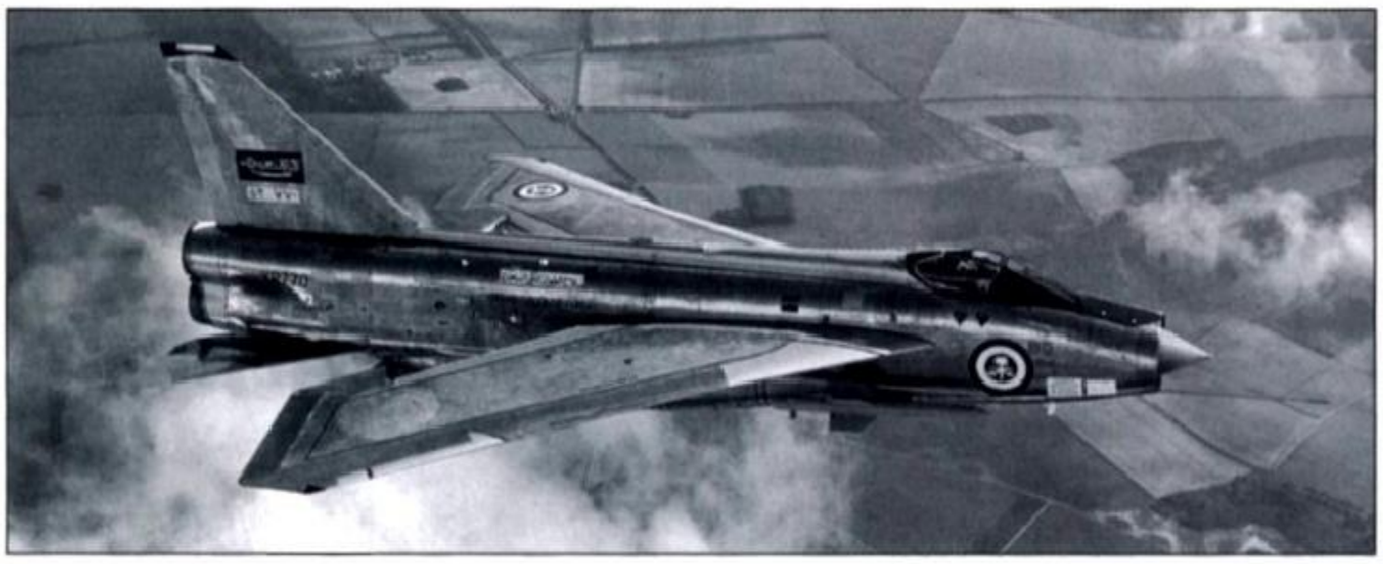
Below: Seen in July 1968, this unique trio comprised a Firestreak-armed T.Mk 55K for Kuwait, Red Top-armed F.Mk 6 of the RAF and an unpainted Saudi F.Mk 53 with bombs and gun pack.



Aircraft destined for both Saudi Arabia and Kuwait made trade show appearances, for which full civilian registrations were applied. Shown above is a Saudi F.Mk 53 at the 1968 Farnborough show, registered G-AWON. It is depicted with twin underwing rocket pods and the twin tank/rocket pod overwing installations. Two Kuwaiti F.Mk 53Ks appeared at the 1969 Paris show, marked as G-AXEE (illustrated above right) and G-AXFW.

As can be gleaned from the scrubbed-out roundels on the wings, this aircraft was the RAF F.Mk 6 painted in 1966 in Saudi colours. The real F.Mk 53 introduced several notable improvements.

headed by the British businessman Geoffrey Edwards, who used his personal contacts to overcome MoD reluctance to help with the campaign, on the grounds that Saudi Arabia lay within the British sphere of influence. Test pilot Jimmy Dell remembers thinking Edwards was merely name-dropping when he announced that he would pull some strings with "Julian and Alec" (Amery and Douglas-Home, respectively Air and Prime Ministers). But, within days four Valiant tankers accompanied three No. 19 Squadron Lightnings from Cyprus to Bahrain, where the Lightnings had their markings removed ready for demonstration in Saudi Arabia. Dell's display culminated in the first sonic boom heard in the country, and a request by the Saudi Minister of Defence, Prince Sultan, that he should fly a low-level supersonic run through the middle of Riyadh. Dell obliged with a high-subsonic, but very, very low run (checking first that the boulevard from the airport to the city centre had no overhead cables). Local papers reported miscarriages, dogs going mad, and other events, but Saudi interest in the Lightning had been sharpened. Not long after, the Saudi air force's test pilot, Lieutenant Hamdan, visited Warton to evaluate the aircraft himself. After a brief hop in a T.Mk 4 with Jimmy Dell, Hamdan (whose previous fast jet experience was limited to the F-86) flew an F.Mk 2 borrowed from the RAF, with a brand new Lightning F.Mk 3 (with Avon 302 engines) flying chase. The F.Mk 2 out-accelerated the F.Mk 3 and went on to Mach 2.1 (faster than the service limit at the time) before the pair returned to Warton for a handful of approaches. This was probably the only time a Lightning pilot exceeded Mach 2 on his first solo. Hamdan was deeply impressed by the Lightning, and was obviously persuasive when he arrived home.



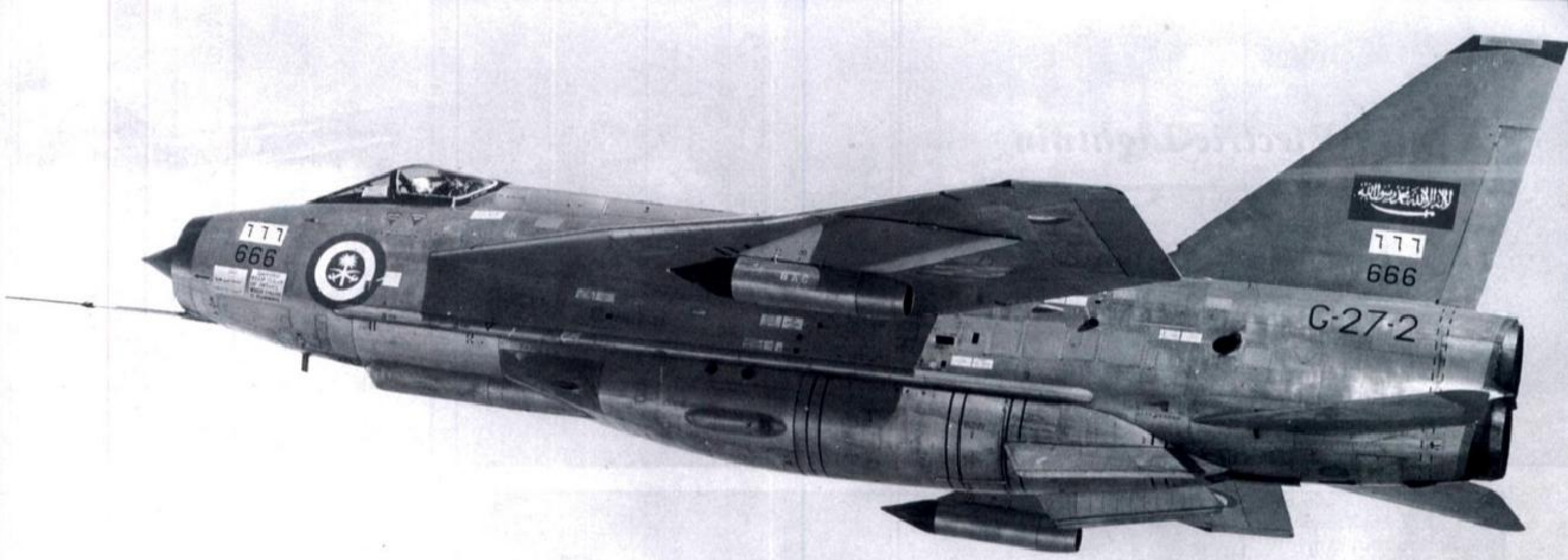
First export sale

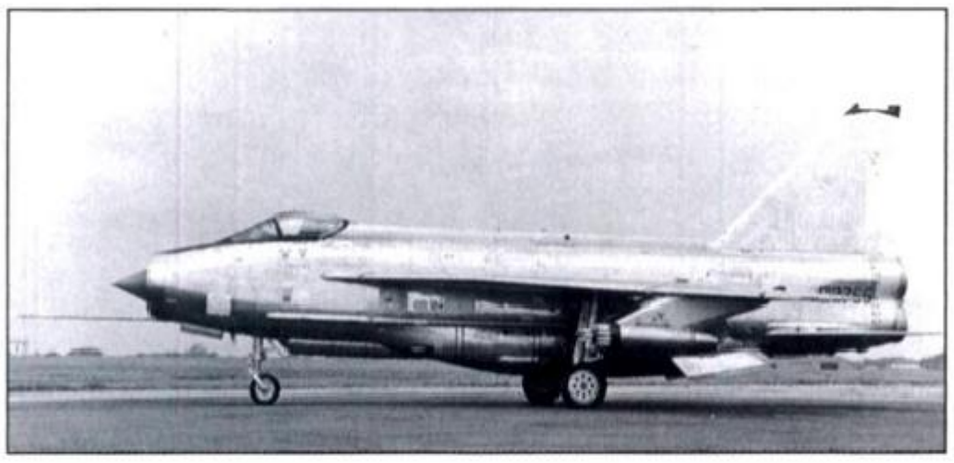
The breakthrough came on 21 December 1965, when Saudi Arabia announced that it was about to place an order (valued at £125 million) with a number of British and American firms to provide a complete new air defence system. Britain's £100 million share made this the country's biggest ever export order. BAC's part in the contract included the supply of 25 Strikemaster trainers and 40 Lightnings. Associated Electrical Industries supplied air defence and surveillance radars, while Airwork Services supplied and supervised training and support services. BAC itself later took over responsibility for all training and support. The US company Raytheon provided HAWK surface-to-air missiles.

Saudi Arabia's Lightnings were to comprise 34 F.Mk 3/6-derived (but multi-role capable) F.Mk 53s, with six T.Mk 55 trainers which would have the fuselage of the T.Mk 5 married to the wing and enlarged ventral tank of

Left: Standing in front of a Saudi F.Mk 53 aircraft are BAC test pilots (from left to right) Jimmy Dell, Pete Ginger, Roland Beamont, Desmond de Villiers and Don Knight. Several pilots, including RAF personnel, were employed to fly the aircraft to Saudi Arabia.

Below: In 1969 Development Batch aircraft XG313 was flown from Boscombe Down to Sydenham, where it was cocooned for shipment to Saudi Arabia. Here it is seen being unloaded from a lighter for use as an instructional airframe at Dhahran.





F.Mk 53 – the export special

Based on the F.Mk 3B study for a multi-role variant of the RAF fighter version, the F.Mk 53 also introduced a number of F.Mk 6 features, such as the large belly tank and the cambered wing, plus many of its own. The overwing fuel tank pylons were further beefed-up to carry weapons, and pylons were also added under the wings. The ventral gun pack was designed for the variant, later being adopted by the RAF F.Mk 6. Power came from the RA.34R Avon Mk 302C, which had a slightly lower dry thrust rating than the Mk 301 of RAF aircraft, but similar afterburning rating. The first F.Mk 53 flew on 19 October 1966.

the F.Mk 6, and provision for full armament. Many observers believed that this version could have formed the basis of a very capable operational fighter for the European environment, where the single-seater pilot was often 'maxed out'.

In order to hasten development, changes from the F.Mk 6 were kept to a minimum, and F.Mk 53 and T.Mk 55 prototypes were produced by conversion of an existing RAF F.Mk 3 (XR722) and T.Mk 5 (XS460). This was quicker than building new prototypes on the line, and they flew in their new guises on 1 November 1966 and 3 November 1967, respectively. Their primary task was to test and clear the weapons and other stores offered with the Saudi aircraft, including the 2-in rockets. The pattern in which rockets were fired had to be entirely changed, because the rockets initially had a tendency to collide on launch, knocking off each other's fins and breaking up in front of the aircraft.

Urgent delivery

In March 1966, in the face of incursions from North Yemen and air attacks by Egyptian aircraft, Saudi Arabia signed a further contract for the urgent supply of six reconditioned RAF-surplus Lightnings, six Hunters, two AEI mobile air defence radars and a number of Thunderbird SAM batteries. Four Lightning F.Mk 52s (actually RAF F.Mk 2s which had been delivered straight to storage at No. 33 MU) and two T.Mk 54s (RAF T.Mk 4s bought back from Nos 56 and 111 Squadrons) were rushed out to Saudi Arabia in July 1966 under Operation Magic Carpet. Another F.Mk 52 (ex-AFDS and A&AEE) was delivered in May 1967 as an attrition replacement. The modifications and reconditioning which produced the F.Mk 52 covered the installation of a ferry radio, repainting in Saudi markings, and routine maintenance.

The Magic Carpet Lightning F.Mk 52s were nominally for training and familiarisation, but were required for immediate operational use. They were the first Lightnings to fly combat missions, countering incursions by Yemeni ground units; interestingly, Egyptian air force activity ceased as soon as the aircraft arrived at Khamis Mushait. The new-build F.Mk 53s were pressed into service as they

Above: Built as an F.Mk 3A for the RAF, XR722 had been held in storage pending upgrade to full F.Mk 6 standard, but was hastily impressed as 53-666 to become the prototype F.Mk 53. Here it is seen carrying MATRA rocket pods on the wing pylons, and is fitted with the optional reconnaissance pack in the weapons bay. This was a rotating capsule which could mount various forward- and downward-looking cameras.

Above left: Another F.Mk 53 displays full MATRA pods and again carries the recce pack. The ventral tank gun installation allowed the Lightning to retain its weapons pack options, which comprised Red Top or Firestreak missiles, 22-cell rocket packs or the camera equipment.

The first four Saudi T.Mk 55s were initially used to form a separate training flight within 226 OCU at Coltishall, the first arriving with the unit in February 1968. In the late 1969 the quartet left for Saudi Arabia, joined at the same time on the newly-formed Lightning Conversion Unit by the last two from the manufacturer.

Saudi Lightnings had various coding systems throughout their career, the last being the introduction of single code letters. By this time only No. 2 Squadron was still flying the type, Nos 6 and 13 Sqns having transitioned to the F-15 Eagle.

Saudi Arabia

The Saudi deal covered 34 F.Mk 53s and six T.Mk 55s, to which was added a single F.Mk 53 attrition aircraft. They were preceded by the seven Magic Carpet aircraft. Saudi F.Mk 53s became operational in the summer of 1969, and saw action in the ground attack role in strikes on Yemeni insurgents at the end of the year. However, for most of their careers they were used in the interceptor role until replaced by F-15s from 1982.

Top right: A pair of No. 2 Squadron Lightnings returns from a training mission to Dhahran. The aircraft have the 'slick' ventral tanks without the gun packs.

Above: This impressive line-up at Dhahran comprises aircraft from the LCU and No. 2 Squadron. The F.Mk 52s and T.Mk 54s were all operated by No. 6 Squadron.

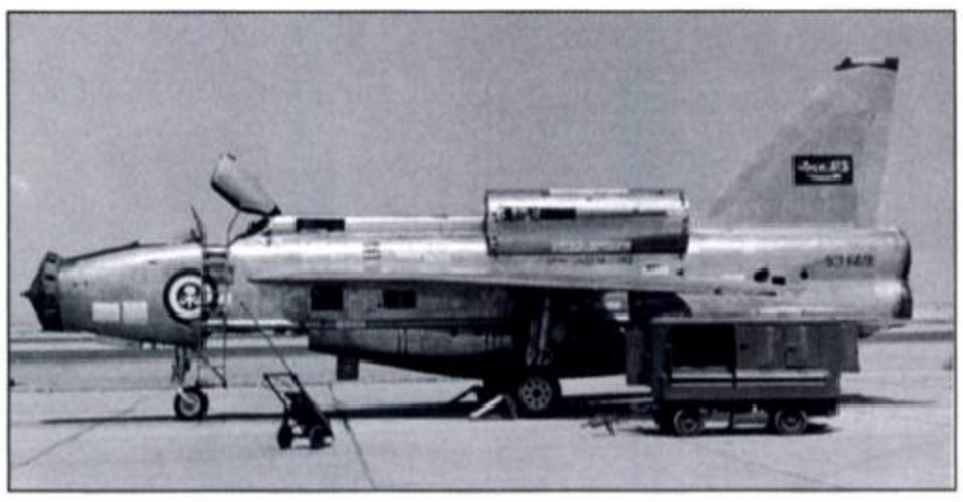
Right: The T.Mk 55 was considerably more advanced than the RAF's T.Mk 5. The F.Mk 6-style ventral tank and variable-camber wing were fitted.

Far right: An LCU F.Mk 53 lights the burners at the start of its take-off roll from Dhahran. The aircraft is fitted with the gun pack and carries inert 1,000-lb (454-kg) bombs for a practice ground attack mission.

arrived in Saudi Arabia, deliveries beginning on 1 July 1968. F.Mk 53s serving with No. 6 Squadron at Khamis Mushait saw combat service again between December 1969 and May 1970, against Yemeni incursions. The Lightnings attacked ground troops and columns using bombs and 2-in rockets, with devastating effect. One F.Mk 53 was shot down by ground fire on 3 May 1970, although its pilot (who ejected safely) and the wreckage were recovered by a C-130 Hercules which flew to the crash site under top cover provided by more Lightnings.

There were accusations that the US stood aside from the Saudi competition to 'allow' Britain to earn dollars with which it would then pay for F-111s, or that US sales efforts were undermined by corruption and bribes, or even that Britain's Labour government was favoured because it was more pro-Arab than either the US administration or the British Conservative government replaced in 1964. In fact, the Lightning won the Saudi order on the basis of performance and operational capability alone, and the type proved successful and popular in service. The Saudi Lightnings lost their ground-attack commitments from 1971, when the Kingdom began receiving Northrop F-5s for use in the fighter-bomber role. This significantly reduced fatigue, and allowed the Lightning squadrons to concentrate on air defence and reconnaissance duties, though the latter role was also soon dropped.

This F.Mk 53 is fully 'unbuttoned' for an engine run, with intake guard fitted, upper engine bay door open and ventral weapon pack removed. The last of 339 Lightnings (plus five static airframes) was an F.Mk 53, making its first flight on 29 June 1972. Serialled 53-700, it was built as a replacement for 53-690 which had been lost on a production test sortie, the only Lightning to be lost on such a flight.



Kuwaiti Lightnings

Kuwait signed a contract for the supply of 12 single-seat Lightning F.Mk 53Ks and two T.Mk 55Ks on 18 December 1966. Unusually, the Kuwaiti variants used the same mark numbers as the Saudi versions, with only the K suffix to differentiate them, indicating that they were very similar to the Saudi aircraft. Because it included a high level of support and training, the Kuwaiti contract was valued at £20 million – a very significant sum in the mid-1960s.

BAC had hoped that the Saudi and Kuwaiti orders might be followed by orders from Jordan and Lebanon (both of whom already operated British-built Hawker Hunters) and perhaps even from Iraq. Unfortunately, an ill-timed announcement that the Lightning would be replaced in RAF service – failing to underline how long-term a plan this was – undermined BAC's sales efforts.

Meanwhile, in Britain, the introduction of the Lightning F.Mk 6 allowed the formation of the seventh and eighth squadrons, Nos 5 and 11, and the delivery of the first new-build F.Mk 6s allowed the conversion of No. 74 Squadron, whose surplus F.Mk 3s permitted the formation of a ninth unit, No. 29 Squadron. This unit replaced No. 56 Squadron, which moved out to RAF Akrotiri on the island of Cyprus. The two Leconfield-based squadrons transferred to RAF Germany: No. 19 Squadron moved to Gütersloh on 23 September 1965, and No. 92 to Geilenkirchen on 29 December 1965. No. 92 Squadron moved again to Gütersloh in February 1968, joining No. 19 close to the Inner German Border. The UK-based Lightning force remained constant at six squadrons, until June 1967 when No. 74 Squadron moved out to RAF Tengah in Singapore. This

Kuwait

With a need to protect its airspace against potential aggression from Iraq, Kuwait bought 14 Lightnings, the first of which (a 'T-bird') flew on 24 May 1968. Deliveries began in December 1968, although most of the batch was built the following year. The Kuwaiti service of the Lightning was short and unspectacular.

left two squadrons at Leuchars (Nos 11 and 23), one at Binbrook (No. 5) and two at Wattisham (Nos 29 and 111). The Leuchars squadrons (assigned to the Northern QRA commitment) and the unit at Binbrook operated F.Mk 6s, which were valued for their longer range capability, while the Wattisham-based squadrons (which more rarely had the opportunity to scramble against Soviet reconnaissance aircraft) retained the short-range F.Mk 3.

As the first unit equipped with the full-standard F.Mk 6, No. 74 Squadron used the new variant's overwing tanks to conduct some very long endurance flights. No. 5 Squadron followed No. 74 Squadron's lead when it traded its interim F.Mk 6s for full production-standard aircraft, conducting a number of long-range flights using the new variant's overwing tanks. They included round-Britain trips of up to seven hours and culminated in an eight-hour flight to Bahrain. The unit deployed to Tengah, Singapore, in December 1969 to take part in joint exercises with FEAF and the RAAF.

In-service modifications

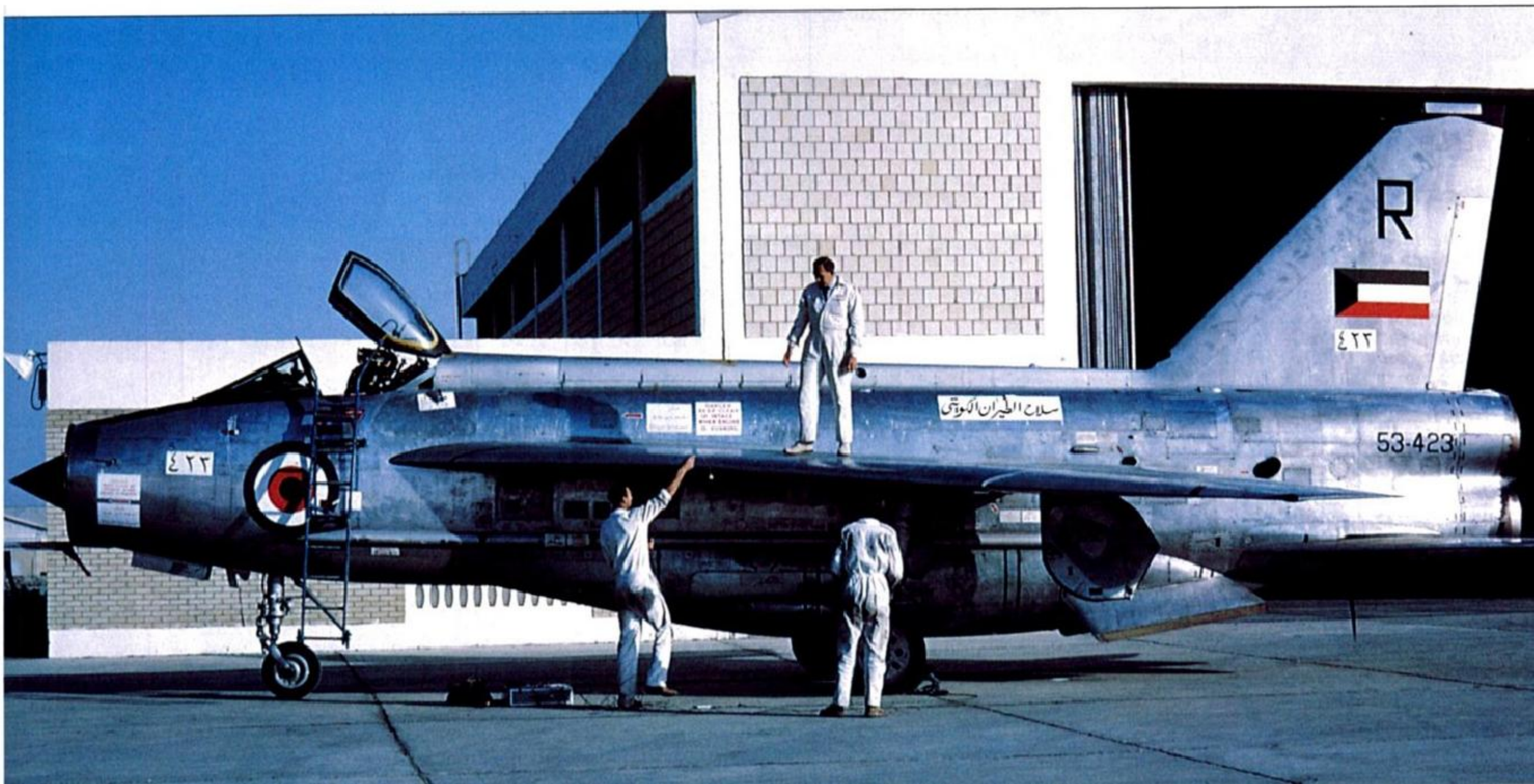
By 1967, with nine front-line squadrons operational (five in the UK), it had become clear that the Lightning was 'here to stay', and sensible improvements (many of them proposed years before) began to be incorporated. In March a spring-loaded 'one-shot' arrester hook was tested on a Leuchars-based F.Mk 6, and was subsequently fitted to most surviving F.Mk 2s, 3s and 6s, and to the T.Mk 5s. In the same year, a probe-tip light was fitted, rapidly becoming standard fleet-wide. At much the same time, the RAF began removing the shallow strakes fitted to early F.Mk 6s (and F.Mk 53s) on the lower 'corners' of the fuselage level with the missile launch rails.

Although originally delivered without any cannon armament, from 1970 most F.Mk 6s were modified to take a pair of 30-mm ADEN cannon in the front of their ventral tanks (an installation developed for the export F.Mk 53). Uniquely, the F.Mk 6 was now able to carry both ventrally mounted cannon and Firestreak or Red Top missiles, giving the type a degree of combat persistence after the two missiles had been fired. The guns also allowed the Lightning to engage aircraft at closer ranges, inside the minimum engagement zones of its missiles. This was a significant capability, enabling the Lightning pilot to engage an enemy aircraft if fired upon during a close intercept, for example, without having to 'drop back' for a missile shot.

Gunnery, long a neglected art among UK-based Lightning squadrons, began to make a reappearance. With the introduction of the Phantom (which relied on a single podded 20-mm cannon on the centreline) it became increasingly clear that the Lightning was a formidable gunfighter. Its two 30-mm cannon packed a heavier and more lethal punch, and were more rigidly mounted, making them significantly more accurate. The RAF's Seed

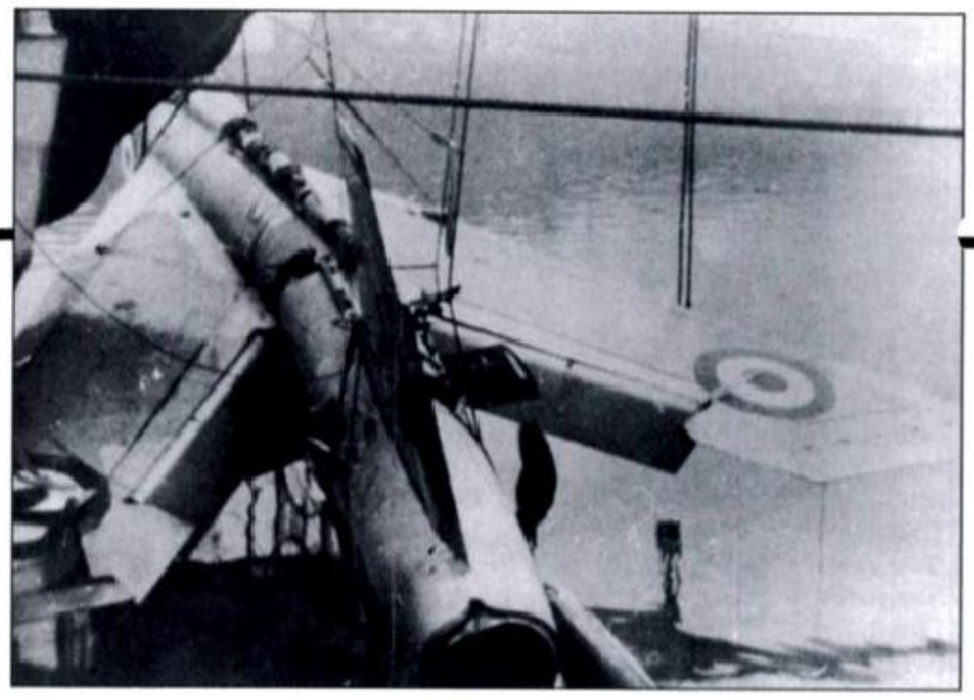
Two pre-delivery photos show a T.Mk 55K. Kuwaiti production ran side-by-side with that for Saudi Arabia, and delivery flights were often made in parallel. Using refuelling and overwing tanks, the flights from Warton usually lasted some six or seven hours. BAC also exported the Strikemaster close support aircraft/ weapons trainer to both Kuwait and Saudi Arabia.

Kuwaiti operations of the Lightning were sporadic at best. The support from BAC/Airwork enjoyed by the Saudi fleet did not exist, and the Kuwaiti facilities were not adequate to maintain and operate this sophisticated machinery. In 1973 the fleet was offered for sale, and finally grounded in 1977 when the far simpler Mirage F1 arrived in service.



F.Mk 6

The Lightning F.Mk 6 became the RAF's ultimate version, equipped with kinked wings, ventral tank, overwing tanks, AI.23B radar and, from 1971, belly guns. The major difference between the F.Mk 3A and full-standard Mk 6 was the ability to carry the overwing tanks, plus a few other minor equipment details. Most of the F.Mk 3As were returned to Warton to be brought up to full F.Mk 6 standard.



The most enduring of the Lightning legends concerns the fate of XS894, seen here being raised for salvage. It ditched during a night exercise in the North Sea in mysterious circumstances. The canopy was down, the seat was still in place, but no trace was ever found of USAF exchange pilot Captain William Schafner.

Above: XR768 was the first full-standard F.Mk 6, delivered to No. 74 Squadron in August 1966. The 'Tigers' took all of the initial batch of F.Mk 6s in preparation for their relocation to Singapore in 1967.

Trophy for aerial gunnery became a semi-permanent fixture in the Binbrook crew rooms, until the introduction of the Tornado F.Mk 3 with its rigidly mounted internal 27-mm cannon and sophisticated gunsight.

The advantages demonstrated by the F.Mk 6 were sufficient to prompt the RAF to modify 31 surviving F.Mk 2s to a standard similar to the F.Mk 2As. It had always been planned to modernise the F.Mk 2s (which had long been viewed as an interim version), and initially it was intended to bring the aircraft to F.Mk 3 standard. In the event, the advent of the F.Mk 3A led to plans for a more comprehensive upgrade, which would have incorporated virtually all of the features of the F.Mk 3A but without cambered wing leading edges or provision for overwing tanks. It would have retained the original Avon engines, which were modified slightly and redesignated Avon Mk 211Rs. The upgrade raised the empty weight of the aircraft from 27,000 lb (12245 kg) to 27,500 lb (12475 kg) (500 lb/230 kg less than the F.Mk 6, but almost 2,000 lb/910 kg heavier than the F.Mk 1 or F.Mk 1A, and capable of carrying 3,100 lb/1405 kg more fuel). Despite this, the F.Mk 2A was quite a performer, its well-matched engine and intake allowing fewer drag-producing vents and intakes on the fuselage, making it particularly clean. F.Mk 2A pilots claimed unrefuelled endurance figures of up to two hours at high level – unheard of in any other Lightning variant.

Upgrades for Germany

When the F.Mk 2A conversion programme finally began, its extent had changed subtly. The aircraft received the enlarged ventral tank (and twin ventral fins) of the F.Mk 6, together with the enlarged square-cut tailfin and the new cambered wing leading edge with increased-chord wingtips. The aircraft were not stressed for the carriage of overwing fuel tanks, unlike the standard production F.Mk 6, and were never modified to carry guns in the forward part of the new ventral tank. The Germany-based F.Mk 2s (and later F.Mk 2As) never lost their overnose guns, and even remained capable of gaining a second pair undernose, albeit at the expense of carrying their primary missile armament. The aircraft was not made compatible with the Red Top missile.

Not all of the F.Mk 2s were converted to F.Mk 2A configuration. A handful had been lost in service, while two (XN725 and XN734) became F.Mk 3As and five (XN729, 767, 770, 796 and 797) were delivered to Saudi

Above: In late 1965 No. 5 Squadron was established to operate the Interim F.Mk 6, although it later received full-standard aircraft. Beneath this formation is Spurn Head, a familiar and comforting sight to the pilots of nearby Binbrook.

Right: A new Lightning squadron – No. 11 – was formed in 1967 at Leuchars to replace the Singapore-bound 'Tigers'. The use of Victor tankers was virtually mandatory on live air defence missions.

English Electric Lightning F.Mk 2A No. 19 Squadron RAF Gütersloh

The 'hybrid' Lightning F.Mk 2A combined some of the fine handling of its F.Mk 2 origins with extra features of the F.Mk 6, and those who also flew the heavyweight F.Mk 6 much preferred the 2A. It was the last version to reach the RAF, and prolonged the Lightning's excellent service in the defence of northern Germany. Thanks to the aircraft being based at Gütersloh, NATO's most easterly base in Germany, reaction times to the border were commendably low.

Ejection seats
Versions of the Martin-Baker Mk 4 seat were fitted to the Lightning, this seat featuring a double-chute extraction system and an 80-ft (24.4-m) per second ejection gun. Initially face-blind initiation was favoured, although the seat-pan handle was later considered preferable.

Fin
The square-cropped fin improved directional stability when the aircraft was carrying missiles. The large ventral tank had two fins instead of the one surface on the smaller tank.

Individual aircraft
XN771 first flew as an F.Mk 2 on 29 August 1962 and was later delivered to the AFDS service evaluation fleet. It returned to BAC for F.Mk 2A conversion, first flying as such on 1 February 1968. Issued to No. 19 Squadron, the aircraft was marked for Flight Lieutenant Tony Paxton.

Firestreak missile
Developed by de Havilland Propeller, the Firestreak was fielded operationally by the Sea Venom. It had an IR telescope which could move through a 15° look angle, and a series of IR sensors for final lock-on and course correction. The solid-propellant motor was forward of the control fins, and the warhead was wrapped around the exhaust tube.

F.Mk 2A differences
The F.Mk 2A was originally envisaged as being a virtual copy of the F.Mk 3 (while retaining Avon Mk 210 engines), and one prototype (XN795) was modified accordingly. However, the final F.Mk 2A conversion retained the AI.23 radar, Firestreak missile armament and nose guns of the F.Mk 2. It did have the square-cropped fin, kinked wing and large belly tank from the F.Mk 6. The new configuration vastly improved range and general performance while retaining gun capability. By leaving the radar and associated systems untouched, the conversion programme was remarkably cheap.

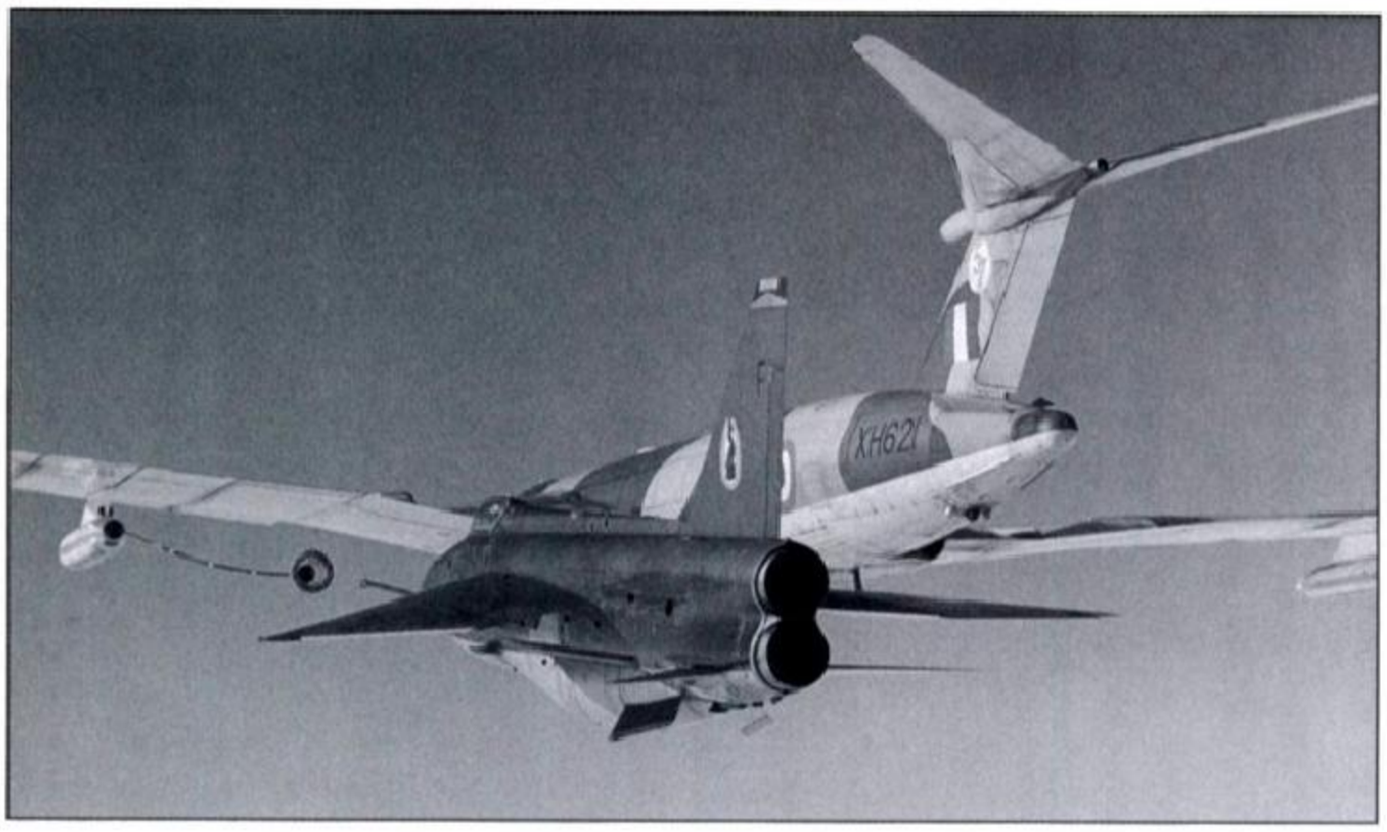
Undercarriage
Dowty Rotol made the undercarriage, to which was fitted Dunlop wheels and tyres. The latter were pressurised to 340 lb/in² (main) and 240 lb/in² (nose). Owing to the small area in contact with the ground, bursts were common and the tyres were rated for just seven landings.

Left: Most F.Mk 2As retained the nose guns, but this aircraft has the troughs faired over and is fitted with the ventral tank guns.

Right: After operating its F.Mk 2As in a silver camouflage, RAF Germany began to apply single-tone dark green to its aircraft in recognition of the low-level fighter role.

F.Mk 2A

To extend the operational life of the Germany-based F.Mk 2s, BAC embarked on a conversion programme adding elements from the F.Mk 6. XN789 was the first to undergo the work, flying again in its new guise on 12 October 1967. Conversion work continued into 1970, using aircraft from the operational squadrons and from storage.



Arabia as F.Mk 52s. Four aircraft (XN768, 769, 779, and 794) remained unconverted and served beside the F.Mk 2As, mainly as hacks and for aerobatic and air combat training. By the time the F.Mk 2A entered service, the Lightning's role in Germany had almost completely changed. A pair of aircraft was maintained on alert, ready to scramble within two minutes of the order to go, tasked to investigate unidentified aircraft in the Buffer Zone (a 30-mile/48-km wide strip of sterile airspace along the inner German border). In Germany, this QRA-type duty was known as Battle Flight, rather than by the initials QRA.

Apart from Battle Flight, day-to-day training was very different to that conducted by the UK Lightning squadrons. High-level intercepts had given way to the mounting of low-level CAPs, at heights at which radar was virtually useless and where the gun (rather than the Firestreak) was the weapon of choice. The Lightnings operated in pairs, intercepting their quarries visually, and refined their techniques and tactics against Phantoms, F-104Gs, Harriers and Jaguars. One unusual mission flown by the Germany-based Lightning squadrons (and by Lightnings deployed from UK bases) were escort missions along the Berlin Corridors. In order to demonstrate the right to maintain an air access corridor to Berlin, a small number of transport aircraft would repeatedly shuttle back and forth for a limited period, heavily escorted by fighters. The Lightnings flew lower and slower than was normal, at 'a good speed to view the scenery'. These escort flights passed without incident. From 1976 the two Gütersloh-based Lightning squadrons began operating from newly-built hardened aircraft shelters, and were the only Lightnings to regularly operate from such accommodation.

Above: RAFG Lightnings received regular visits from Victors to maintain their refuelling skills.

Right: A few unmodified F.Mk 2s were retained in Germany long enough to receive camouflage. Like the F.Mk 1/1As in the UK, they were used mainly for target facilities work.

The first generation bows out

The F.Mk 6 and F.Mk 2A were in widespread service by the mid-1970s, but there were still examples of the very first marks in service until the middle of 1974. The very last F.Mk 1As in use were the aircraft assigned to No. 226 OCU for training fledgling Lightning pilots. By 1974, however, there were plenty of redundant F.Mk 3s and the best of these replaced the remaining F.Mk 1As during June 1974.

The OCU's single-seaters augmented a fleet of two-seat trainers for most of the Lightning's service life, with one or two twin-stick Lightnings serving in each front-line squadron, too. The old T.Mk 4s were mostly scrapped with the final withdrawal of the F.Mk 1 and F.Mk 1A from the OCU, and of the F.Mk 2A from the front line. The T.Mk 5 was far more representative of the in-service F.Mk 3 and F.Mk 6, and with the drawdown in the Lightning force

There was little to distinguish the F.Mk 2A from the F.Mk 6 externally, but underneath there was a wealth of difference. The retention of the lower-powered Avon 210s did not hamper the F.Mk 2A's operational effectiveness.

Nos 19 and 92 Squadrons acquired and enhanced an enviable record in the low-level regime. In addition to the low CAPs, the squadrons were also tasked with high-level patrols over the 'clutch' airfields of Bruggen, Laarbruch and Wildenrath.

Below: Two 'Cobras' Lightnings break for the camera. The principal raison d'être of the RAF Germany Lightning force was to man the Battle Flight, the equivalent of the UK QRA. The requirement was for the aircraft to be launched within five minutes, but with practice the crews often got this down to under the three-minute mark.

there were enough of them to fulfil the anticipated training requirement. The OCU itself lasted only until September 1974, when the reduced training requirement was taken over by a new 'C' Flight of No. 11 Squadron.

In the very early days individual squadrons had a two-seat Hunter on strength to meet training requirements, but the F.Mk 1, F.Mk 1A and F.Mk 2 units soon gained one or two T.Mk 4 Lightnings. The advent of the F.Mk 3 and F.Mk 6 rendered the T.Mk 4 of marginal utility for squadron-level training requirements, since they did not have the same OR.946 instrumentation. The T.Mk 4s (like the redundant F.Mk 1s and F.Mk 1As) remained useful for basic type conversion, but for instrument flying and standardisation the Lightning F.Mk 3 and F.Mk 6 stations reverted to specially equipped Hunter T.Mk 7s (with OR.946) until the definitive Lightning T.Mk 5 was ready.

Second-generation trainer

The T.Mk 5 was effectively the trainer version of the F.Mk 3, with Avon 301 engines, the increased-area, square-cut fin and the small ventral tank. The first two production T.Mk 4s were converted to serve as the T.Mk 5 prototypes. Because it was converted 'on the line', the second of these, XM967, was actually the first to fly, on 29 March 1962. The prototypes were converted and flight tested at Filton (BAC being overwhelmed by TSR.2 and single-seat Lightning work), where the front fuselages for production T.Mk 5s were also built. The T.Mk 5 programme was significantly delayed by the loss of the prototype, while further delays meant that the first production T.Mk 5 to fly (actually the second aircraft, XS417) did not take to the air until 17 July 1964. Deliveries of the 22 production T.Mk 5s to the OCU began on 20 April 1965.

The Lightning T.Mk 5 was not a particularly popular aircraft, not least because it tended to be an instrument of torture, conducting the highest-workload, most difficult conversion training sorties. "The best thing that could happen to the T.Mk 5," observed one wag "would be if someone flew it into the simulator." One difference between the T.Mk 4 and the T.Mk 5 was that the former had a central throttle quadrant for the instructor in the right-hand seat, allowing him to fly the aircraft 'normally' with his left hand on the throttle and his right hand on the stick, as in all single-seat versions and as in the left-hand seat of the trainer. For unknown reasons, the central quadrant was removed in the T.Mk 5 and replaced by a throttle box on

T.Mk 5 front-fuselage construction and development work was undertaken at Filton, from where XM967 made its first flight. Another T.Mk 4, XM966, was also converted to T.Mk 5 standard, but this was lost when the fin disintegrated at Mach 2.

T.Mk 5

The second-generation trainer was developed in parallel with the F.Mk 3, and featured all of the new fighter's developments, including Avon Mk 301s, OR.946 cockpit with strip-type ASI, square-cropped fin and Red Top. The first prototype was intended to be the second production T.Mk 4, but was completed on the line as the new variant. It first flew on 30 March 1962. Production reached 22 airframes for the RAF, one of which (XS460) was hastily converted as the first T.Mk 55.

226 OCU

In May 1971 the OCU at Coltishall underwent a major change, resulting in the three constituent squadrons becoming two, with corresponding adoption of new markings. The T.Mk 4s were still used for initial conversion and also for training pilots destined for the RAF Germany F.Mk 2/2As, while the T.Mk 5s continued as advanced trainers for F.Mk 3/6 pilots. Partnering the T.Mk 4s were the surviving F.Mk 1As, and together they adopted the markings of No. 65 Squadron. The T.Mk 5s, and supporting F.Mk 3s, did not receive a shadow number, instead adopting their own markings for 2T Squadron.

This formation shows three of the four variants used by 226 OCU in the early 1970s. In the foreground is an F.Mk 1A with a T.Mk 4 behind it, both resplendent in the markings of No. 65 Squadron, while behind is a T.Mk 5 of 2T Squadron, the advanced training unit.

Below: Sporting an unusual white spine for an APC deployment, a T.Mk 5 from No. 5 Squadron gets airborne from Binbrook. A section of the spine covering the AVPIN starter tank was often painted white to avoid it overheating in the sun. Lacking the option of carrying overwing tanks, the T.Mk 5 needed five refuellings to reach Akrotiri, as opposed to the F.Mk 6's three.

the starboard wall of the cockpit. The instructor therefore had to fly the aircraft left-handed, with his right hand on the throttle. This was not too much of a problem until the instructor wanted to initiate an overshoot. In most Lightning variants he would ease back with his right hand, and push firmly forward with his left; if he did this in the T.Mk 5, he would close the throttles and push the nose down. This ludicrous state of affairs was an accident waiting to happen, but, fortunately, no Lightning T.Mk 5 was lost as a result.

New command: new fighters

Fighter Command disappeared in 1968, to be replaced by the new Strike Command's No. 11 Group. This organisational change was soon followed by the introduction of what would eventually be the Lightning's successor, the McDonnell Douglas F-4 Phantom. The defence cuts which slashed the Royal Navy's carrier force led to the diversion to the RAF of 25 of the Phantoms on order for the Fleet Air Arm. This allowed No. 43 Squadron (previously a Hunter-equipped fighter-bomber unit in the Middle East, but dormant for two years) to reform with Phantom FG.Mk 1s in September 1969. The squadron was based at Leuchars alongside two Lightning F.Mk 6 units, which continued in-place while operational procedures and tactics for the Phantom were developed and refined. The presence of a third air defence squadron at Leuchars allowed No. 11 Squadron to make deployments to Singapore and Malta in 1969 and 1970. Although No. 43 Squadron mounted its first QRA on 23 March 1970, and was declared operational on 1 July 1970, it did not actually fully replace No. 11 Squadron until 22 March 1972, when the unit finally moved south to join No. 5 Squadron at RAF Binbrook.

The first front-line Lightning squadron to disappear was No. 74, which disbanded on 25 August 1971 as part of the reduction of British forces East of Suez. No. 74 performed its role in the Far East with panache, despite many difficulties. Pilots had to return to the UK if training in the simulator was required, while Singapore's constricted airspace frequently imposed constraints on operations. Many expected the squadron (widely regarded as the RAF's premier fighter squadron, and the first unit with the Lightning, the F.Mk 3 and the full-up F.Mk 6) to relocate or

In service the T.Mk 5s operated with 2T Squadron of 226 OCU for advanced training, and singly with the F.Mk 3/6 squadrons. Shown here are those of No. 11 Sqn (far right, above), No. 23 (right) and No. 111 (far right). Note the 23 'zap' on the fin of the No. 11 Sqn example.

F.Mk 3s at Wattisham

Wattisham was the second base to receive F.Mk 3s, following soon after Leuchars. At the Suffolk airfield No. 111 Squadron received its new aircraft first, in late 1964, followed the next year by No. 56. In 1967 the 'Firebirds' left for Cyprus, swapping over with No. 29 Sqn, which had flown Javelins.

Above: Soon after 'Treble One' converted to the F.Mk 3 the squadron was called upon to lead the flypast for Sir Winston Churchill's funeral, and later in 1965 provided a 12-aircraft formation team for the Paris air show. It was No. 111 Sqn F.Mk 3s which successfully intercepted U-2Cs which were operating from nearby Wethersfield, much to the chagrin of the USAF.

reform in the UK, but oblivion was its lot. The squadron ferried its F.Mk 6s to Akrotiri for use by No. 56 Squadron and then disappeared, reportedly because it had put up some unspecified 'black'. Official displeasure may have been prompted by the squadron's readoption of black tails and spines while it served with the Far East Air Force, in direct disobedience of the January 1966 Air Council instruction banning such markings. No. 74 Squadron's T.Mk 5 was returned to the UK by ship, but was so badly damaged in transit that it was scrapped on arrival, although official secrecy ensured that this fact never became public and that no-one had to account for the incident. The disappearance of one of the eight front-line squadrons went a long way towards addressing the developing shortage of Lightning airframes. The ex-No. 56 Squadron F.Mk 3s were ferried back to the UK, where the surplus of F.Mk 3s eventually allowed the retirement of F.Mk 1s and F.Mk 1As from the training role.

While Saudi Lightnings saw plenty of action, the Royal Air Force Lightning force never fired a shot in anger. The RAF Lightning came close to seeing operational service in July 1974, when Turkey invaded Cyprus. No. 56 Squadron flew 110 Battle Flight sorties, intercepting a number of Turkish fighter-bombers and keeping them clear of the British Sovereign Base Areas.

Re-roled Phantoms

Although the RAF's own Phantom FGR.Mk 2s were delivered from 1968, the aircraft were initially used to replace No. 38 Group's (mainly Hunter-equipped) fighter-bomber squadrons, and to re-equip and replace Canberra and Hunter strike and reconnaissance units in RAF Germany. It was only with the service introduction of the Jaguar that Phantom FGR.Mk 2s became available for use in the air defence role. The newly reroled Phantoms initially equipped the squadrons of the Wattisham wing, since they operated the gunless, shorter-ranged Lightning F.Mk 3s. When No. 54 Squadron re-equipped with the Jaguar in March 1974, it passed its Phantoms to a new No. 111 Squadron. This unit began conversion at Coningsby on 1 July 1974, officially reforming at Wattisham on 1 October 1974, when the Lightning squadron disbanded.

Many people thought that the Lightning's days were numbered, and when Nos 29 and 111 Squadrons gave up their Lightnings to convert to the Phantom many of their aircraft were simply scrapped, despite the fact that most were relatively 'young' in fatigue terms. Ten years later the last Lightnings at Binbrook were being carefully cosseted to preserve fatigue life, and aircraft were flown until the very last flying hour of their calculated lives. The low-houred F.Mk 3s, which had been so hastily cut up at Wattisham and Leconfield, would have been very welcome during the Lightning's final months of service. Fortunately, some of the aircraft escaped the axe and were reallocated as hacks to the remaining units; one F.Mk 3 (XR718) was actually

Above left: No. 29 Sqn served at Wattisham with its F.Mk 3s from 1967 to July 1974.

Far left: With its F.Mk 3s, No. 56 Squadron devised a new colour scheme. It was this scheme which eventually pushed the top brass too far, resulting in a directive standardising Fighter Command unit markings.

After operating the Interim F.Mk 6 aircraft (below), No. 5 Squadron acquired full-standard aircraft (left) from late 1966. This example, seen in the early 1970s, carries live Red Top missiles, overwing ferry tanks and ventral gun pack.

RAF Germany

The two Leconfield Lightning squadrons left for Germany in 1965, with No. 19 going to Gütersloh and No. 92 to Geilenkirchen. The force was concentrated at Gütersloh in January 1968, this base being much further east (and consequently much closer to the East/West border). Here the squadrons adopted the long-range F.Mk 2A. Unlike the UK squadrons, which undertook their Armament Practice Camps at Akrotiri, the RAFG squadrons went to the NATO training base at Decimomannu in Sicily for their APCs.

Above: The low-level role prevalent in Germany required some special tactics, especially for gun firing as the weapons were angled to fire slightly upwards. To shoot down a very low-flying target, the Lightning pilot had to approach above it, then roll inverted and pull into a dive; roll erect again and then fire before pulling out of the dive.

Below right: The T.Mk 4s were kept to the end of RAFG operations, receiving the drab colour scheme with the rest of the fleet from May 1972.

Below: In Germany, Harriers (illustrated) and Buccaneers provided much of the 'trade' for the Lightning squadrons. In 1972 the Gütersloh Battle Flight was scrambled to intercept a Harrier. The pilot had ejected but the aircraft continued to fly – eastwards. To avoid a potentially embarassing situation, the Lightnings shot down the Harrier over open country. Lightnings are also believed to have shepherded stray 'visitors' from East Germany, some of which were genuinely lost while some were believed to have been on probing flights.

rebuilt after having been stripped for spares and relegated to Wattisham's fire dump. This aircraft had previously served with No. 226 OCU, and had been refurbished at Filton in September 1974 for use as a sales demonstrator, though foreign interest in the short-range F.Mk 3 failed to materialise.

Even at Wattisham, the Lightning era was not quite over. No. 56 returned to the UK in January 1975, where some Lightning support equipment, spares and experienced personnel still remained following the disbandment of No. 29 Squadron on the last day of 1974. No. 56 took over a handful of F.Mk 3s (including XP694, 701, and 702) from the Wattisham-based units. The squadron's tenure at Wattisham was brief, although long enough to celebrate the Diamond Jubilee of the 'Firebirds' and to win the Dacre Trophy as the RAF's top fighter squadron. The unit disbanded as a Lightning squadron on 28 June 1975, with the new Phantom squadron at Coningsby formally taking over the historic numberplate the next day, moving to Wattisham on 7 July.

The Binbrook-based squadrons had already taken a number of F.Mk 3s on charge from late 1972, and others went to No. 23 Squadron at Leuchars from June 1974 (XP706, 750, 751, and 759). No. 23 was the next Lightning squadron to disband, on 31 October 1975, transferring its aircraft to Binbrook and its numberplate to a new Phantom unit forming at Coningsby. Its place at Leuchars was taken by the new Phantom-equipped No. 111 Squadron.

Gütersloh replacements

The UK ADR was now defended by two Phantom squadrons at Leuchars, with two more at Wattisham and one at Coningsby. There was no move to replace the two Binbrook-based Lightning squadrons, which, it was anticipated, would serve until replaced by the air defence version of the Tornado. However, there were enough Phantoms to allow the re-equipment of the two Lightning units in RAF Germany. No. 19 Squadron disbanded on 31 December 1976, passing on some of its aircraft to No. 92 Squadron which disbanded on 1 April 1977. The Phantom element of No. 19 stood up at Wildenrath on 1 January 1977, to be joined by No. 92 on 1 April. This was a sad day for the men of the Gütersloh wing, as the Chief of the Air Staff pointed out in a letter to the Station Commander. "I can sense that the disappearance of the Lightning will be a sad day for you ... but you chose the right way to finish the Lightning era, with the best TACEVAL results for an Air Defence Wing in NATO history."

Coincidentally, as the RAF Lightning force contracted to

Above: The best known TFF aircraft were those from Wattisham, adorned with the 'Wattisham cat' motif on the fin. This is an F.Mk 1, showing the extremely clean airframe which helped make these stripped-down lightweights the fastest of the Lightnings.

Left: No. 85 Sqn's Meteor F.Mk 8s (illustrated) and Canberras were regular targets for Lightning pilots.

Target facilities

In addition to regularly intercepting other aircraft, the Lightning force also had its own target fleet. After trials with aircraft at the Binbrook-based FCTU, several F.Mk 1/1As were issued to the Lightning bases to act as target facilities aircraft. They were stripped of radar and armament, and fitted with a Lüneberg lens radar reflector, flying as supersonic prey for the front-line aircraft to practise intercepts.

two front-line squadrons, one of the aircraft's two foreign customers also retired the aircraft from service. In Kuwait, the Lightning was finally replaced by the Mirage F1 in 1977, after a futile 1973 attempt to sell the aircraft to Egypt. The Kuwaiti aircraft were later surveyed by BAe with an eye to possible repurchase for refurbishing and resale, but their condition was too poor to make their recovery economical. Most survivors were retired to display duties: three are pole-mounted in vic formation at al Jaber AFB to this day, two more are displayed at Kuwait International Airport and the Kuwait Technology Institute, and one is in store for the air museum. Two more were damaged during the Gulf War and were subsequently dumped at Ali Al Salem AFB.

Leaner force

The much-contracted Lightning force had dropped from its nine-squadron, 150-aircraft peak in 1968-70 to a two-squadron 35-aircraft force by the last day of 1977. This level remained constant for the next 10 years, with aircraft fatigue life being spread around a much larger fleet, much of which was in long-term storage at any one time. The two front-line squadrons standardised on the Lightning F.Mk 6 as their operational aircraft, although each unit also had two-seat T.Mk 5s and single-seat F.Mk 3s for training and other duties. The training unit (initially No. 11 Squadron's 'C' Flight, then the Lightning Training Flight) had a mix of T.Mk 5s and F.Mk 3s. They were usually augmented by a single F.Mk 6, configured without guns (i.e., with maximum internal fuel) and with a Luneberg lens (in a dummy Red Top airframe) which served as a radar target.

The squadrons continued with their usual routine of QRA duty, an annual Armament Practice Camp for air-to-air gunnery training and ACE qualification at Akrotiri, and an annual missile camp at RAF Valley. Morale at Binbrook was soon sky-high. The Lightning force was an elite, drawing the very best pilots from training and flying the RAF's

Above: After the TFFs were disbanded at the end of 1973, the target aircraft were operated for a time by based squadrons. This ex-Leuchars TFF F.Mk 1A is seen in the markings of No. 23 Squadron.

Left: In addition to the cat tail badge, Wattisham TFF Lightnings were also named after famous felines. Here is **Felix.**

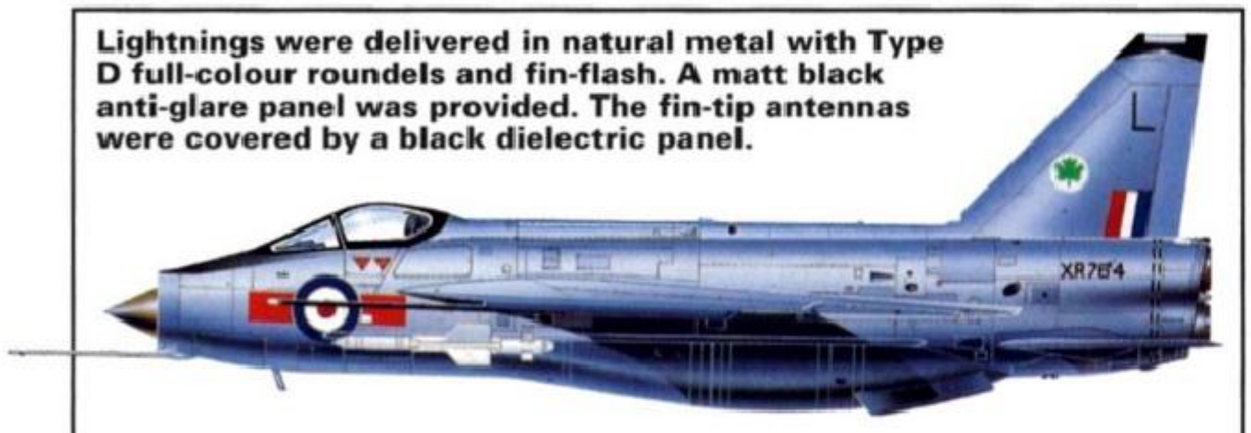
In August 1979, Binbrook hosted the celebrations for the Lightning's 25th anniversary, with aircraft being painted up in the colours of former users. Unfortunately, the British weather marred the flying display, for which a 25-aircraft flypast had been planned and rehearsed.

only single-seat fighter, an aircraft to which the 'classic' label had already been applied. The Lightning (within its limitations) was also an effective combat aircraft, especially while pilots of the new 'teen'-series jets were still 'finding their feet' and were unable to get the best from their aircraft.

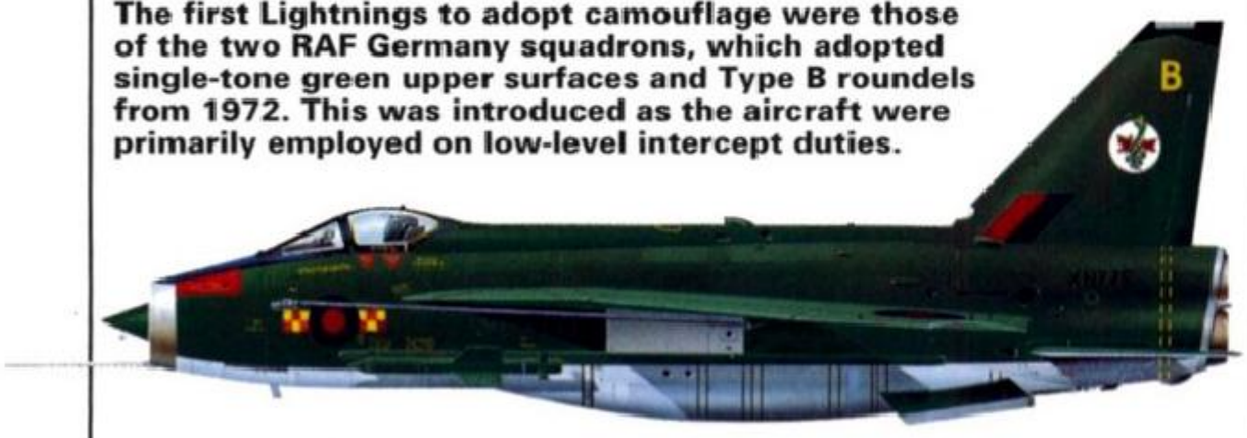
'Old age and cunning' often allowed Lightning pilots to triumph over pilots flying younger and more capable fighters. On one occasion, an F.Mk 3 avoided a USAF F-16 pilot's attempts to achieve a Fox 2 (SRAAM kill) and then a Fox 3 (guns kill), but the gun camera film debrief showed that the F-16 pilot kept trying. When asked what he had been trying to do, the American replied, "I was going for a

Lightning colours

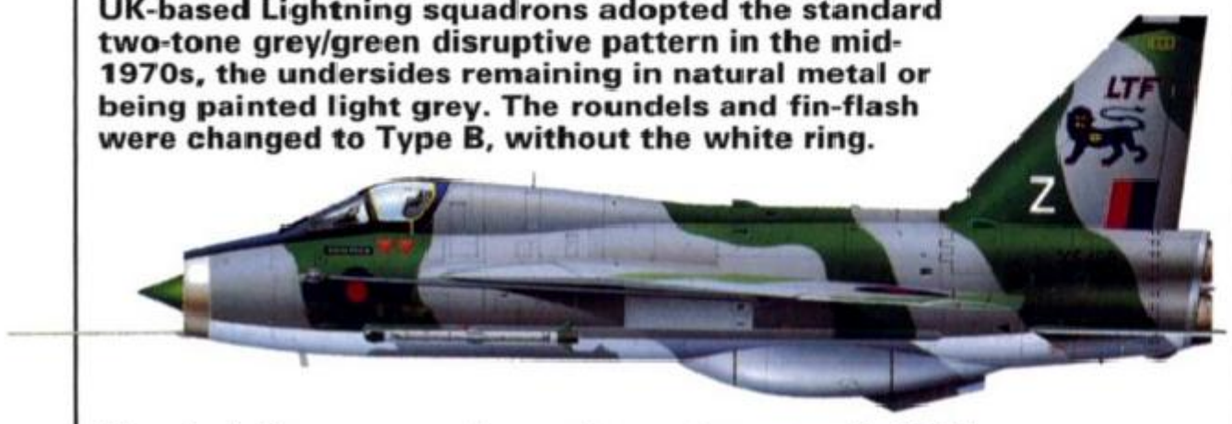
Lightnings were delivered in natural metal with Type D full-colour roundels and fin-flash. A matt black anti-glare panel was provided. The fin-tip antennas were covered by a black dielectric panel.



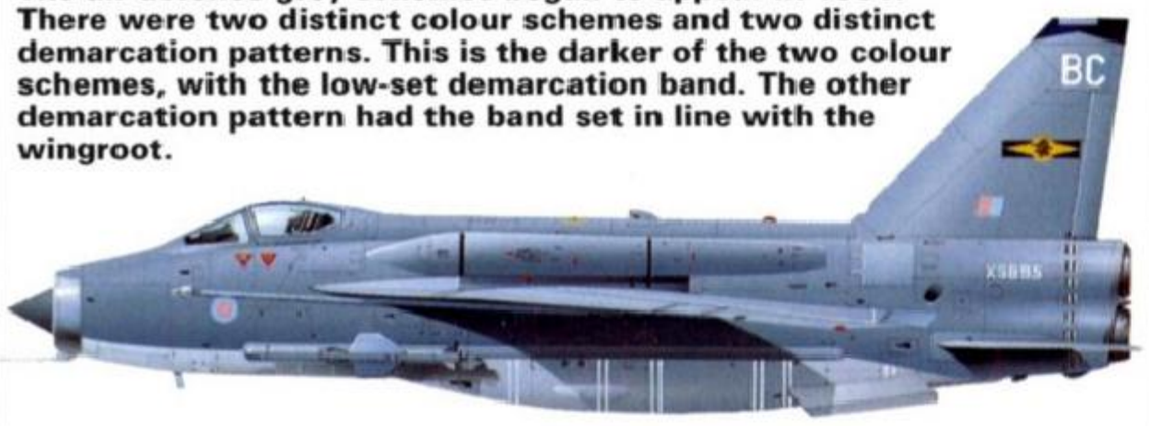
The first Lightnings to adopt camouflage were those of the two RAF Germany squadrons, which adopted single-tone green upper surfaces and Type B roundels from 1972. This was introduced as the aircraft were primarily employed on low-level intercept duties.



UK-based Lightning squadrons adopted the standard two-tone grey/green disruptive pattern in the mid-1970s, the undersides remaining in natural metal or being painted light grey. The roundels and fin-flash were changed to Type B, without the white ring.



The air defence grey schemes began to appear in 1981. There were two distinct colour schemes and two distinct demarcation patterns. This is the darker of the two colour schemes, with the low-set demarcation band. The other demarcation pattern had the band set in line with the wingroot.

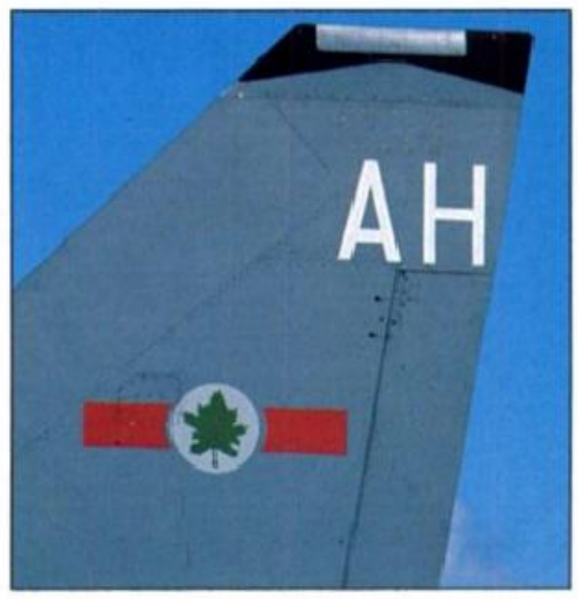


XR770 was the first aircraft to receive an air defence grey camouflage, appearing in August 1981 and demonstrating the lighter of the two basic colour schemes. The aircraft also wore large Type B roundels, although they were toned down.

Aircraft for both Saudi Arabia and Kuwait were delivered in natural metal. A few Saudi aircraft may have later received a two-tone desert scheme, although perhaps only for decoy or display purposes.

No. 5 Squadron

In 1917/18 No. 5 Sqn had close associations with the Canadian Corps, hence the maple leaf squadron badge.



In the 1980s No. 5's tail markings combined the squadron badge with the original red nose bar.

No. 5 added sharkmouth markings to three aircraft during an APC. Note that the tail maple leaf does not have a blue circle background.

No. 11 Squadron

No. 11 Sqn traditionally wore yellow and black nose markings (above), and two black eagles on the tail (above right). The latter is the squadron badge and signifies speed and strength, as well as commemorating the fact that for most of World War I the unit flew two-seat aircraft. In the air defence grey era the squadron combined both on the tail (right), along with the squadron's 'Bx' codes in white. Shown below is a No. 11 Sqn aircraft shortly after the move to Binbrook, when the large tail eagles were adopted. When the squadron was at Leuchars it had the eagles in the standard white circle as specified by the Air Council.

No. 19 Squadron

No. 19's traditional blue/white checks adorned the nose (above) while the squadron's dolphin badge was on the tail (right). This commemorated the unit being the first to fly the Sopwith Dolphin.

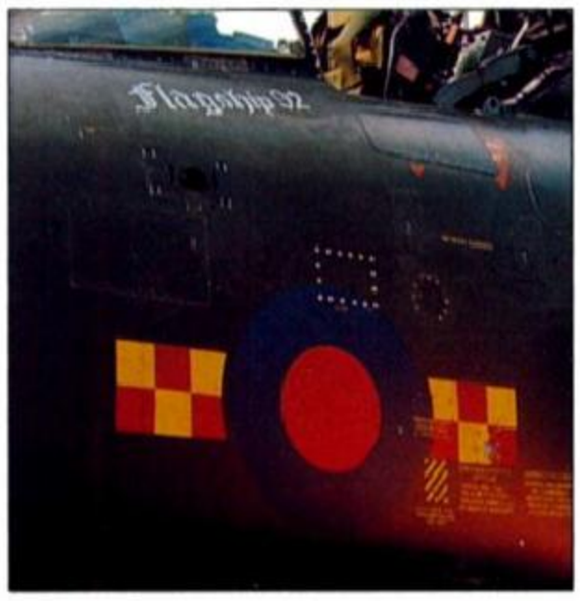
No. 74 Squadron

No. 74 always had the tiger-stripe nose bars, with a tiger's head badge on the tail. The tiger had been adopted and used during World War I. The black tail and spine were adopted in 1962, with stylised fin-flash in 1964. The markings were revived (albeit without black spine) during the unit's time in Singapore.

No. 23 Squadron

No. 23's official badge is an eagle preying on a falcon, but in the post-war years the smaller bird was deleted from the fin badge. This badge, and the nose bars, are seen on a target facilities F.Mk 1A.

No. 92 Squadron



No. 92 used yellow/red checker nose markings. This aircraft was assigned to the commander and was appropriately named 'Flagship 92'.

No. 92's squadron badge consisted of maple leaves (signifying Canadian ties in World War I), and a cobra to represent being one of the East Indies' gift squadrons in World War II. The blue tail and sloping fin-flash survived until camouflage was introduced.

No. 29 Squadron

No. 29's Lightning F.Mk 3s wore the 'XXX' markings in red on a white band (bordered in red), with the unit's badge on the fin. The latter consisted of a red eagle preying on a yellow buzzard, symbolising victory in air combat.

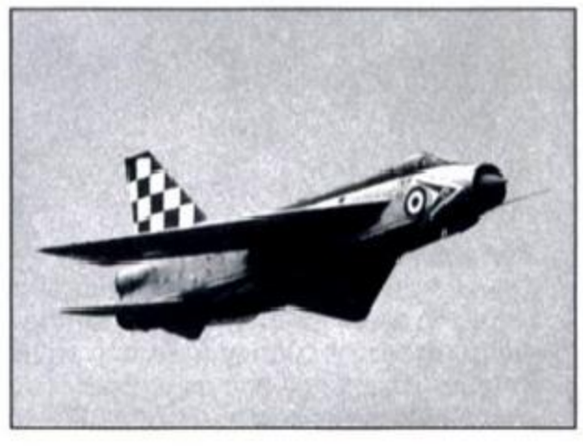
No. 111 Squadron

'Treble One' modified its traditional black bar markings to become a lightning flash, edged in yellow. The aircraft seen below has also been 'zapped' by other units, notably the Luftwaffe's JG 71 'Richthofen'.

The complicated squadron badge on the tail comprises a cross (to signify Palestine, the unit's main area of operation in World War I), three seaxes to represent the county of Essex (where it was based for some of the early war and post-war period), and the crossed swords to represent London (which it was defending).

No. 56 Squadron

The 'Firebird' Phoenix badge reinforces the squadron motto 'Quid si coelum ruat' (What if heaven falls).



The short-lived checkertail scheme in the mid-1960s featured the 'Firebird' badge small on the nose.

The second prototype T.Mk 4 provides excellent reference to the top-side markings in the original natural metal finish, including position of roundels, walkway markings, refuelling points, anti-glare panels and canopy markings.

226 OCU/No. 145 Sqn

From 1966 to 1971 226 OCU aircraft wore the St George's Cross nose markings. Note the Saudi T.Mk 55 aircraft in this Coltishall line-up.

No. 145's badge consisted of a sword (symbolising fighting) and a Palestinian Cross (signifying the squadron's associations with No. 14 Sqn). Shown below is the original high-colour fin marking.

226 OCU/No. 65 Sqn

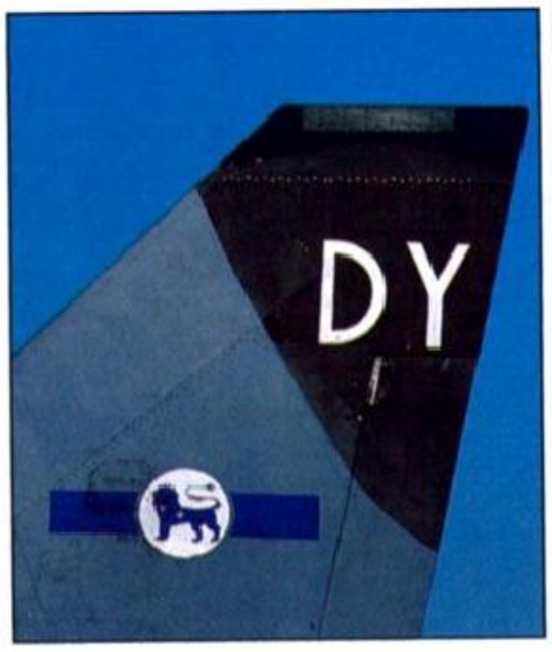
In 1971 No. 1 Sqn of 226 OCU adopted No. 65 Sqn shadow markings. The 15 swords in the tail badge (right) signified the number of aircraft shot down in a memorable World War I engagement.

Target Facilities Flights

The three TFFs adopted markings of their own. Binbrook TFF used blue nose bars and station lion on the tail, while Leuchars adopted St Andrew's Cross tail markings and Scottish lion nose bars. At Wattisham the aircraft wore a cartoon cat figure on nose or tail, together with yellow/black nose bars (right). For a short while a name was carried below the cockpit.

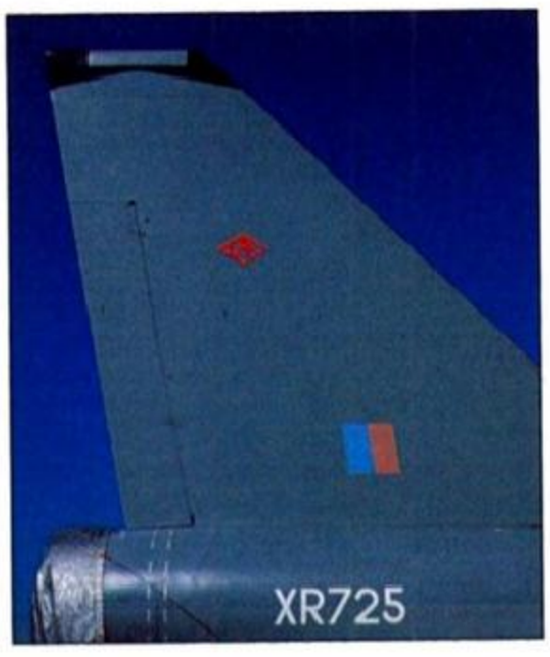
Lightning Training Flight

The LTF adopted the Binbrook station badge as its own markings, with dark blue nose bands. The LTF wore 'Dx' tailcodes in white.



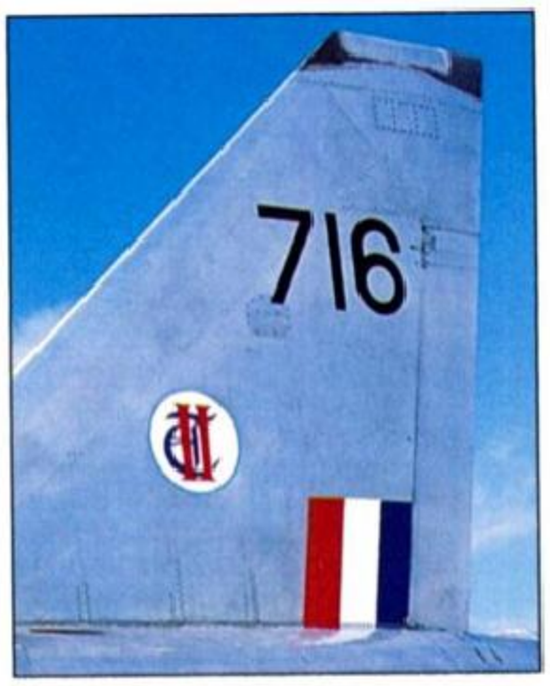
Lightning Augmentation Flight

The simple LAF badge was usually applied in Dayglo tape to the unit's borrowed aircraft. Tailcodes were usually removed.



226 OCU/2T Sqn

The second OCU squadron, 2T, did not adopt any shadow number, and had to devise its own markings in 1971. These consisted of blue nose triangles outlined in white, and a representation of the squadron number for the fin.



Powerplant
All Lightnings were powered by a pair of engines mounted one above the other and staggered, with the lower engine forward. This gave the smallest possible fuselage cross-section, but necessitated the use of different-length jet pipes and made the engines vulnerable to collateral damage if one failed. The top engine was removed upwards (after removal of the jet pipe, which rolled out aft) while the lower engine was dropped down. An engine change could theoretically be achieved in four hours, though in practice it usually took days. The F.Mk 3 was fitted with the ultimate Lightning Avon engine, the 16,300-lb st (72.51-kN) Avon Mk 301 with fully-variable reheat. Like previous Lightning Avons, the Mk 301 was a great 'fighter pilot's engine', remarkably tolerant of throttle mishandling and disturbed intake airflow. Fuel consumption remained horrifying, however. At 600 kt (1111 km/h; 690 mph) at low level, each engine would devour 200 lb (91 kg) of fuel per minute, giving a typical CAP time of 12 minutes even close to the North Sea coast. The pilot had to return to base with a minimum of 1,600 lb (726 kg) to allow for diversions or missed approaches. In air-to-air combat, the fuel burn rose even higher, and an ACT mission in an F.Mk 3 would be flown in the airfield overhead, and could last as little as 10 minutes. The F.Mk 3 was lighter than the similarly powered F.Mk 6, and during the 1980s was the 'hot-rod Lightning'. Use of reheat was mandatory on the F.Mk 6 for take-off, which was heavier and therefore faster on approach, and more tail heavy. However, the bigger wing of the F.Mk 6 generated more lift than the original wing, as fitted to the F.Mk 3, and this cushioned the aircraft on touchdown, making the F.Mk 6 easier to land. Although powered by the less powerful 14,430 lb st (64.21 kN) Avon Mk 210 (RA.24R), the F.Mk 2 was claimed by many to be the sweetest-handling and best performing front-line Lightning, since its intake and engine were better matched. The fastest Lightnings were the stripped-down lightweight F.Mk 1s and F.Mk 1As used by the Target Facilities Flights and the OCU, since they had an incredible thrust-to-weight ratio and a less draggy airframe, with fewer vents, intakes and drains.

Supersonic interceptor
If an inbound target was flying at supersonic speed, it would be regarded as hostile; this was just as well, since the Lightning would most likely have lacked fuel to visually identify the target or even to make a second attack. With GCI giving range and bearing information, the Lightning would accelerate to Mach 1.3 and climb, with the computer giving cues to turn and climb to put the aircraft in the best firing bracket. With a maximum detection range of 23 miles (37 km), and a closure rate of 30 miles (48 km) per minute, there was very little time to get a lock-on, sort out the intercept geometry and fire. Painting the target on radar, the Lightning pilot would raise the scanner. As soon as the radar started tracking the target the sight picture changed, producing a steering dot, then a launch warning light, at which point the pilot squeezed the trigger. Launch range was a function of target speed, but typically the missile would fire automatically at about 6 miles (10 km), for a 12-second flight. Should a reattack be necessary, the Lightning pilot would turn hard (a hard turn could be sustained at Mach 1.3) onto the target's tail, with his head down in the radar display, trying to avoid bleeding off too much energy and departing, or of simply being unable to catch the disappearing foe.

Fuel system
From the beginning, the P.1 and Lightning never carried enough fuel. Even with the original Sapphire engines, the 5,000 lb (2268 kg) of internal fuel originally provided was never going to be sufficient, and the wings were redesigned with fuel in the leading edge and flaps (but not the undercarriage doors, though this was proposed) raising the total to 5,728 lb (2597 kg). Production Lightnings gained a detachable, jettisonable ventral tank containing another 2,000 lb (907 kg) of fuel, while the F.Mk 6, export aircraft and rebuilt F.Mk 2As were given a ground-removable ventral tank containing 4,880 lb (2214 kg), or 4,280 lb (1941 kg) when the cannon pack was fitted. Refuelling could be undertaken using pressure refuelling points below each wing, or by gravity refuelling points above the wing. The F.Mk 6 and export versions could carry 4,320 lb (1960 kg) of extra fuel in two overwing tanks (though they restricted the Lightning to subsonic speeds, and were used only for ferrying). Even the F.Mk 6 was severely constrained by its relatively tiny internal fuel capacity, however. With the aircraft's short endurance, Lightning pilots did not amass flying hours quickly. The first pilot to reach 3,000 hours was Squadron Leader Dave Carden, in 1983, the culmination of 18 years and five full tours on the aircraft! Fortunately, immense training value was packed into the short sorties, and only the very best pilots even made it as far as the Lightning OCU, where many 'failed to make the grade'. These factors kept the accident rate remarkably low. Only 74 Lightnings were lost in 34 years of front-line service, coincidentally the same quantity as the number of first-generation Harriers lost in RAF service between 1961 and 1992. A huge share of the Lightning losses were caused by engine fires and failures, and fortunately a high proportion of the pilots escaped successfully.

Wings and tail surfaces
The sharply swept wings of the Lightning mounted ailerons on the cut-off tip with trailing-edge flaps and (on production aircraft) a fixed (but detachable) le edge. The wing was joined at the aircraft centreline and was installed as a or piece unit. This made removal of the wings difficult and time consuming afte manufacture was complete. The wing was built around two primary spars, to which were affixed closely spaced ribs and stringers. The wing torsion boxes formed the aircraft's primary internal fuel tankage, this being restricted by th space taken up by the main undercarriage wells. The tailplanes were of simil construction to the wings, but were one-piece slab units, mounted to the airc on a steel shaft permanently attached to the tailplane root, but detachable at powered flying control unit. Some honeycomb construction was used at the trailing edge. The fin was of similar construction, though with a dielectric tip with a one-piece powered rudder of honeycomb construction, with a spar an for extra rigidity and strength.

Starting
Most production Lightnings used Isopropyl Nitrate Mono Fuel (AVPIN) starters, with a 3-Imp gal (13.6-litre) tank in the spine containing sufficient fuel for six starts. The highly combustible AVPIN burned without oxygen, and 0.5 Imp gal exploding was sufficient to propel the No.1 Avon to turn fast enough to start. With a tailwind, acrid fumes would blow into the cockpit: without, even tiny spillages could strip paint from the fuselage.

Structure
The Lightning was of conventional all-metal construction. The nose section was built in two halves to allow for easy access for the installation of wiring, pneumatic and hydraulic lines. The windscreen and canopy frames were manufactured from heavy forgings, with stretched acrylic Perspex mouldings and an optically-flat armoured glass windscreen. After final assembly, the cockpit was pressure tested to 2.5 times the maximum pressure expected in service. The radar was mounted in a centrebody in the intake, this being carried on a vertical aerofoil in the intake itself. This nose section was then joined, at the aft cabin pressure bulkhead, to the main fuselage, which was built on ovoid frames (and '8-section' frames aft of the wings) with mid-point longerons, stringers and chemically etched skin panels. Access apertures were of heavier gauge material to maintain structural integrity, and access panels were chemically-etched with internal stiffeners. Wing, tailplane and tailfin mountings were machined castings with steel bushes. Steel was also used in the nose gear bay, the engine mounts, the nose ring and the jet-pipe fairing, with titanium around the jet pipes and engines.

Avionics
Apart from the Ferranti AIRPASS radar, the Lightning was fitted TACAN for navigation. From the F.Mk 2, the aircraft could use a Offset TACAN display, allowing the pilot to 'move' a TACAN be a location of his choice, thereby allowing him to make instrume downs at non-TACAN airfields. TACAN was great at high level, nearly useless at low level, where its range was extremely limit quick wits, a map and stop-watch became essential. The Lightn was fitted with ILS, and UHF homing was also provided. At the its life, when the Lightning was serving only as a radar target fo Tornado radar development, some aircraft were fitted with an IN this gave no read-out for the pilot and was used only to help del the technicians and engineers assessing the performance of the by accurately pinpointing the Lightning's actual position. Defens avionics were non-existent, with no RWR, ECM or even chaff/fl dispensers.

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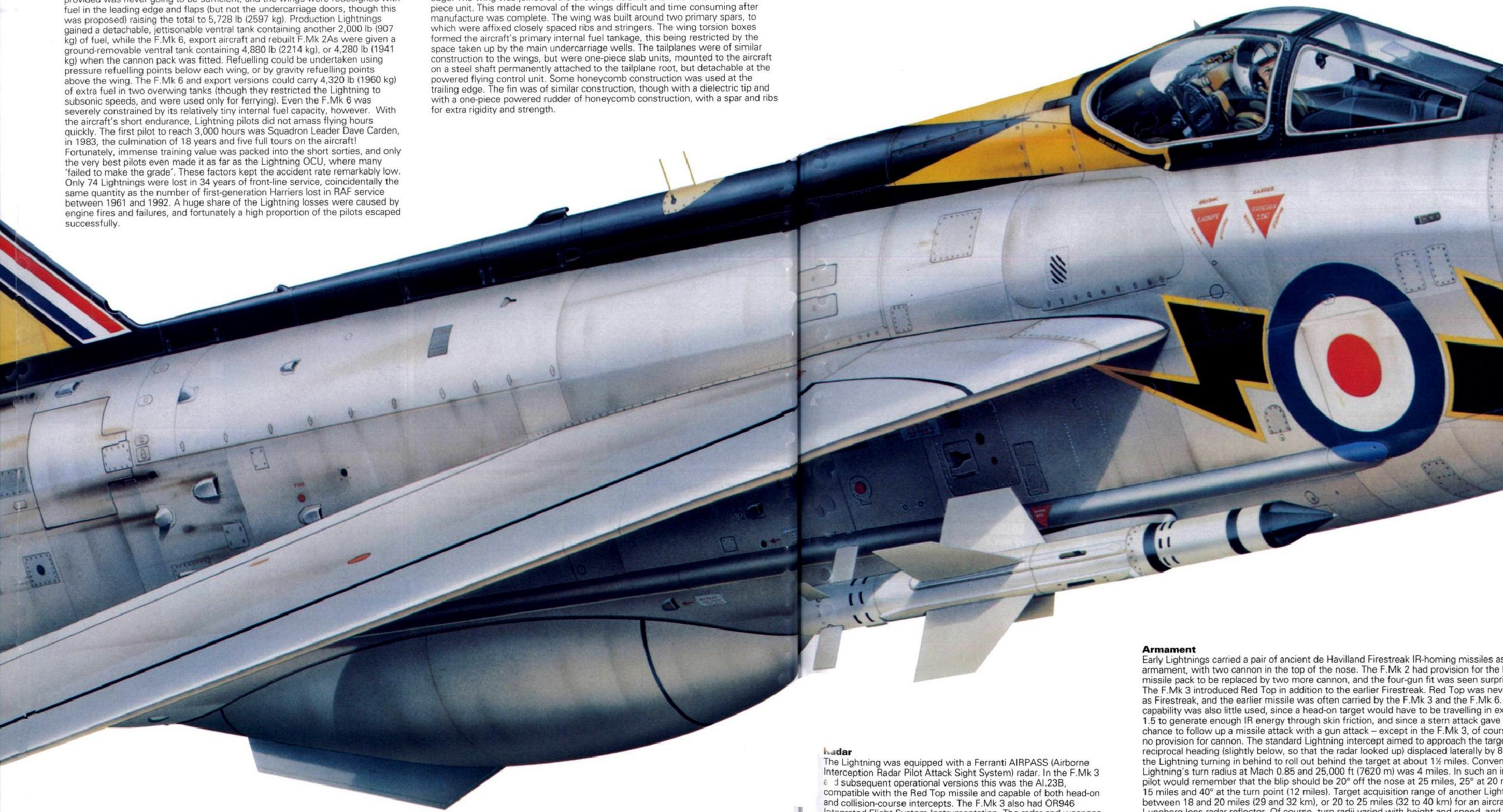

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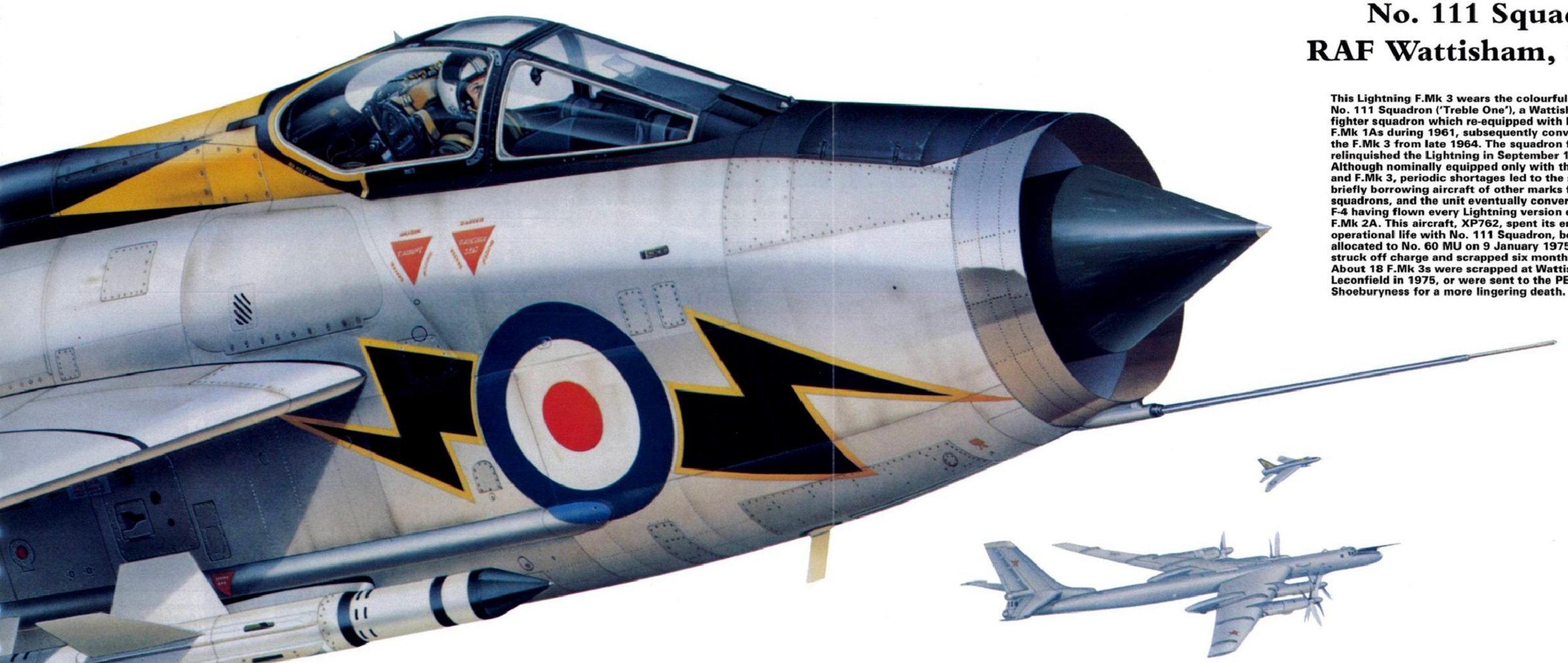
Radar
The Lightning was equipped with a Ferranti AIRPASS (Airborne Interception Radar Pilot Attack Sight System) radar. In the F.Mk 3 and subsequent operational versions this was the AI.23B, compatible with the Red Top missile and capable of both head-on and collision-course intercepts. The F.Mk 3 also had OR946 Integrated Flight System Instrumentation. The radar and weapons system were far from automated, with no interface between the two apart from the pilot. The antenna was controlled using a hand-controller, sliding in and out to drive the antenna up and down, from +7° to -8°. Moving the handle left and right moved the target acquisition marker, and two thumbwheels scrolled the marker up and down and adjusted the gain. Small switches nearby changed the range scale and operated other modes. Perhaps fortunately, the Lightning usually operated under GCI control, or sometimes under the direction of ancient AEW Shackletons, so the tiny detection range was not as much of a problem as it might have been. For debriefing peacetime practice intercept missions the Lightning had a G90 camera below the intake bullet, with another in the spine filming a repetition of the pilot's radar display and a simple clock face. The radar was improved over the years, and by the end, RAF Lightnings had AI.23C or AI.23D standard radar. An automated Auto Attack system was developed for the Lightning, but was never procured by the RAF on financial grounds.

Armament
Early Lightnings carried a pair of ancient de Havilland Firestreak IR-homing missiles as armament, with two cannon in the top of the nose. The F.Mk 2 had provision for the missile pack to be replaced by two more cannon, and the four-gun fit was seen surpri The F.Mk 3 introduced Red Top in addition to the earlier Firestreak. Red Top was nev as Firestreak, and the earlier missile was often carried by the F.Mk 3 and the F.Mk 6. capability was also little used, since a head-on target would have to be travelling in ex 1.5 to generate enough IR energy through skin friction, and since a stern attack gave chance to follow up a missile attack with a gun attack – except in the F.Mk 3, of cours no provision for cannon. The standard Lightning intercept aimed to approach the targe reciprocal heading (slightly below, so that the radar looked up) displaced laterally by 8 the Lightning turning in behind to roll out behind the target at about 1½ miles. Conven Lightning's turn radius at Mach 0.85 and 25,000 ft (7620 m) was 4 miles. In such an i pilot would remember that the blip should be 20° off the nose at 25 miles, 25° at 20 15 miles and 40° at the turn point (12 miles). Target acquisition range of another Light between 18 and 20 miles (29 and 32 km), or 20 to 25 miles (32 to 40 km) for an aircra Luneberg lens radar reflector. Of course, turn radii varied with height and speed, and more curves for the pilot to memorise. As if this were not difficult enough, the Lightn to calculate the target's inbound heading by measuring change of displacement over closure, and calculated the target height at 10 miles by multiplying scanner elevation was vital since the height difference between target and fighter had to be reduced to ft (609 m) to stand any chance of success, preferably with the fighter just below the t Locking on to the target, the radar provided range and azimuth information, but no clo missile was fired, the Lightning then had to roll inverted and pull inverted, in order to from the target. From 1970, the Lightning F.Mk 6 was modified to accept a gun insta normally carried two handed ADEN 30-mm cannon in the nose of the ventral fuel tan 120 rounds of ammunition. This installation had been designed for the export F.Mk 5 to Kuwait and Saudi Arabia. Ball or armour-piercing rounds were used for peacetime t high-explosive rounds were used operationally, each being capable of downing an en The guns weighed 192 lb (87 kg) and were capable of firing between 1,200 and 1,400 minute (a six-second burst). The guns were manufactured with a left- or a right-hand could not be made interchangeable. No. 111 Squadron acquired three F.Mk 6s from N Squadron during May 1974, but they were not fitted with gun packs and were used o experience to those pilots due to be posted to F.Mk 6 squadrons.

English Electric Lightning F.Mk 3
No. 111 Squadron
RAF Wattisham, 1965

This Lightning F.Mk 3 wears the colourful insignia of No. 111 Squadron ('Treble One'), a Wattisham-based fighter squadron which re-equipped with Lightning F.Mk 1As during 1961, subsequently converting to the F.Mk 3 from late 1964. The squadron finally relinquished the Lightning in September 1974. Although nominally equipped only with the F.Mk 1A and F.Mk 3, periodic shortages led to the squadron briefly borrowing aircraft of other marks from other squadrons, and the unit eventually converted to the F-4 having flown every Lightning version except the F.Mk 2A. This aircraft, XP762, spent its entire operational life with No. 111 Squadron, being allocated to No. 60 MU on 9 January 1975, then struck off charge and scrapped six months later. About 18 F.Mk 3s were scrapped at Wattisham and Leconfield in 1975, or were sent to the PEE at Shoeburyness for a more lingering death.



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Lightning was equipped with a Ferranti AIRPASS (Airborne rception Radar Pilot Attack Sight System) radar. In the F.Mk 3 subsequent operational versions this was the AI.23B, patible with the Red Top missile and capable of both head-on collision-course intercepts. The F.Mk 3 also had OR946 grated Flight System Instrumentation. The radar and weapons em were far from automated, with no interface between the apart from the pilot. The antenna was controlled using a hand- troller, sliding in and out to drive the antenna up and down, from ° to -8°. Moving the handle left and right moved the target uisition marker, and two thumbwheels scrolled the marker up down and adjusted the gain. Small switches nearby changed range scale and operated other modes. Perhaps fortunately, the tning usually operated under GCI control, or sometimes under direction of ancient AEW Shackletons, so the tiny detection e was not as much of a problem as it might have been. For iefing peacetime practice intercept missions the Lightning had 90 camera below the intake bullet, with another in the spine ng a repetition of the pilot's radar display and a simple clock . The radar was improved over the years, and by the end, RAF tnings had AI.23C or AI.23D standard radar. An automated Auto ck system was developed for the Lightning, but was never ured by the RAF on financial grounds.

Armament

Early Lightnings carried a pair of ancient de Havilland Firestreak IR-homing missiles as their primary armament, with two cannon in the top of the nose. The F.Mk 2 had provision for the Firestreak missile pack to be replaced by two more cannon, and the four-gun fit was seen surprisingly often. The F.Mk 3 introduced Red Top in addition to the earlier Firestreak. Red Top was never as reliable as Firestreak, and the earlier missile was often carried by the F.Mk 3 and the F.Mk 6. The head-on capability was also little used, since a head-on target would have to be travelling in excess of Mach 1.5 to generate enough IR energy through skin friction, and since a stern attack gave the pilot the chance to follow up a missile attack with a gun attack – except in the F.Mk 3, of course, which had no provision for cannon. The standard Lightning intercept aimed to approach the target on a reciprocal heading (slightly below, so that the radar looked up) displaced laterally by 8 miles, with the Lightning turning in behind to roll out behind the target at about 1½ miles. Conveniently, the Lightning's turn radius at Mach 0.85 and 25,000 ft (7620 m) was 4 miles. In such an intercept, the pilot would remember that the blip should be 20° off the nose at 25 miles, 25° at 20 miles, 32° at 15 miles and 40° at the turn point (12 miles). Target acquisition range of another Lightning was between 18 and 20 miles (29 and 32 km), or 20 to 25 miles (32 to 40 km) for an aircraft with a Luneberg lens radar reflector. Of course, turn radii varied with height and speed, and this meant more curves for the pilot to memorise. As if this were not difficult enough, the Lightning pilot had to calculate the target's inbound heading by measuring change of displacement over 5 miles of closure, and calculated the target height at 10 miles by multiplying scanner elevation by 10. This was vital since the height difference between target and fighter had to be reduced to within 2,000 ft (609 m) to stand any chance of success, preferably with the fighter just below the target. Locking on to the target, the radar provided range and azimuth information, but no closure rate. If a missile was fired, the Lightning then had to roll inverted and pull inverted, in order to avoid debris from the target. From 1970, the Lightning F.Mk 6 was modified to accept a gun installation, and normally carried two handed ADEN 30-mm cannon in the nose of the ventral fuel tank, each with 120 rounds of ammunition. This installation had been designed for the export F.Mk 53, as delivered to Kuwait and Saudi Arabia. Ball or armour-piercing rounds were used for peacetime training, but high-explosive rounds were used operationally, each being capable of downing an enemy aircraft. The guns weighed 192 lb (87 kg) and were capable of firing between 1,200 and 1,400 rounds per minute (a six-second burst). The guns were manufactured with a left- or a right-hand feed, and could not be made interchangeable. No. 111 Squadron acquired three F.Mk 6s from No.23 Squadron during May 1974, but they were not fitted with gun packs and were used only to give experience to those pilots due to be posted to F.Mk 6 squadrons.

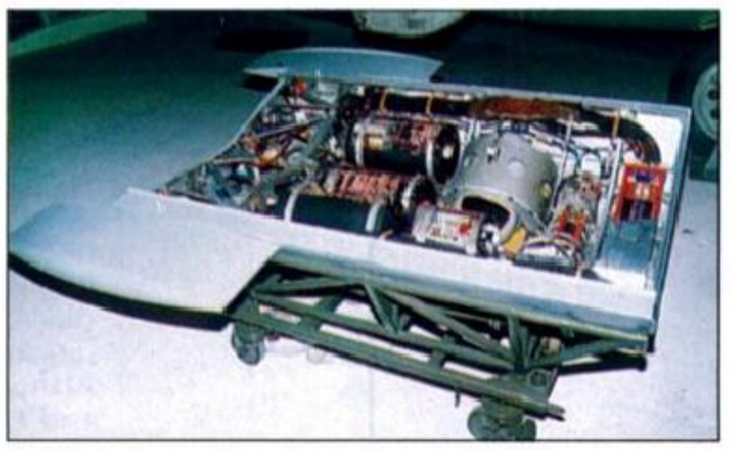
RAF Lightning colours

For most of its career, the Lightning wore a natural metal finish overall. This was a reasonable compromise for low conspicuity at high level, yet offered the advantage over a pale grey or blue colour scheme of reduced weight, reduced drag, and easier maintenance. On a less practical note, the colour scheme was redolent of the silver-doped finish worn by the RAF's classic interwar biplane fighters, and provided an excellent canvas for colourful squadron markings. Even with an unchanging basic overall colour scheme, there was plenty of scope for variation in minor details, and especially in the size, shape and position of unit markings and the tricolour flash on the tailfin. The earliest Lightnings had a fin flash of standard proportions, only slightly taller than it was wide, and aligned with its trailing edge following the rudder hinge line, thus making it slightly swept. This would be the standard position for Lightning fin flashes until the type retired from service. When squadrons began applying special colour schemes the fin flash was often reshaped and relocated, often becoming more steeply raked to align with the leading edge of the fin itself. Nos 23, 56 and 111 Squadrons all used steeply raked fin flashes close to the fin leading edge, and extended them (to varying heights), making them longer and thinner.

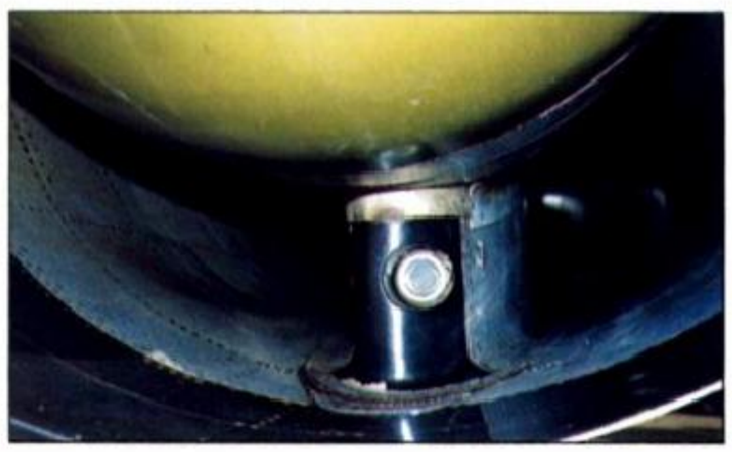
The first major change to the basic Lightning colour scheme came in RAF Germany, where the low-level air defence role had steadily increased in importance. From 1972, therefore, the surviving F.Mk 2s, F.Mk 2As and T.Mk 4s received NATO dark green topsides, with a demarcation line running from the tailplane forward to the missile pylons and on to the intake. Apart from a small panel, the fuselage sides below the wing were in the upper surface colour, down to the demarcation line. In the UK, it was the need to camouflage aircraft on the ground, as much as during low-level flight, which drove a change to the all-natural metal scheme. Following trials with grounded aircraft at Binbrook, evaluating a number of alternative colour schemes, on 18 August 1975 a No. 11 Squadron T.Mk 5 (XS452) flew with dark green upper surfaces, with reduced-diameter red and blue roundels and a red and blue fin flash in the normal position. The LTF's XS458 subsequently flew with dark sea grey topsides, as part of the same trial. In the event, neither colour scheme was selected for fleet-wide application and, instead, Binbrook's Lightnings received a two-tone disruptive camouflage of green and grey on their topsides, with silver or sometimes light grey undersides. National insignia were toned down, with small red/blue roundels and a red/blue fin flash, while the bars flanking the nose roundels were reduced in size. Code letters were applied in white for conspicuity.

During late 1980, Binbrook's Lightning units adopted two-letter codes, with each unit having its own series. No. 5 Squadron took codes running 'AA'-'AZ', 'BA'-'BZ' went to No. 11 and 'DA'-'DZ' went to the LTF. The codes 'CA'-'CZ' were reserved for the planned third squadron. Scarcely was the new camouflage paint dry than Binbrook's aircraft began to emerge from overhaul wearing a new air defence grey colour scheme, similar to that applied to Phantoms and Tornado F.Mk 2s. The decision to repaint the Lightnings again resulted from the realisation that while the two-tone grey/green camouflage was excellent at low level, or for hiding the aircraft on the ground, it did increase conspicuity at higher level. While RAF Phantom and Tornado interceptors eventually received a single air defence colour scheme, with the close shades of medium sea grey and Barley grey overall, the Lightnings wore a variety of grey schemes, at least three distinct versions proved to be permanent, as opposed to short-lived trials. Arguably the most effective of the schemes used medium sea grey top surfaces and Barley grey undersides, with the demarcation between the two colours about halfway down the fuselage, level with the wing leading edge. The ventral tank was often left unpainted. Some aircraft wearing these colours had Barley grey only on the lower surfaces of the wings and tailplanes, with the ventral tank left in natural metal, or painted silver. The other main Lightning air defence schemes used dark sea grey topsides and medium sea grey undersurfaces, with either a high demarcation (at about wing leading-edge level) but more usually lower down, at missile rail and tailplane level. The new air superiority colour schemes were introduced only slowly, and when No. 11 Squadron finally disbanded in 1988, several of its aircraft still wore grey/green camouflage. The first aircraft painted in the new 'Barley grey' colour scheme was No. 5 Squadron's XR770 (actually the CO's aircraft) which emerged from the paint shop during the summer of 1981. It had full-size roundels and fin flash, but these were toned down in pale blue and pink, later grey aircraft having national insignia in the same colours, but of much reduced proportions. There were a number of special colour schemes, confined to the addition of coloured tailfins and spines with enlarged unit markings.

Lightning details



An interchangeable weapons pack was fitted, accommodating the launch equipment for Firestreak (left) and Red Top (right) missiles. Mks 1 and 2 Lightnings also had a twin 30-mm cannon pack option, while export F.Mk 53s could carry a rocket pack.



The radome is supported by two vertical struts. The lower strut incorporates the R 90 gun camera.

Lightning F.Mk 6 cutaway

1 Pitot head boom
2 Intake bullet fairing
3 Ferranti AIRPASS radar antenna/scanner
4 Engine air intake lip
5 Hot-air de-icing
6 Bullet lower spacer
7 G 90 camera
8 Radar pack
9 Bullet upper spacer (electrical leads)
10 Forward equipment bay
11 Forward fuse box
12 Capacitor box
13 LOX container
14 Light fighter sight control unit
15 De-icing/demister air
16 Radar ground cooling air coupling
17 Nosewheel door mechanism torque shaft and operating rods
18 Nosewheel bay
19 Nosewheel doors
20 Nosewheel strut
21 Roller guide bracket
22 Forward-retracting nosewheel
23 Castor auto-disconnect
24 Shimmy damper and centring unit
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26 Flight refuelling probe (detachable)
27 Nosewheel strut pivot pin
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32 Engine power control panel
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34 Instrument panel shroud
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45 Chemical air driers
46 Starboard (armaments) console
47 Ejection seat face-blind/firing-handle
48 Air conditioning duct
49 Rear pressure bulkhead
50 Martin-Baker ejection seat
51 Port instrument panels
52 Cockpit ladder attachment
53 Cockpit emergency ram air intake
54 Lower (No. 1) engine intake duct frames
55 Firestreak weapons pack
56 Launch sequence units
57 Control units
58 Port missile pylon
59 Firestreak missile
60 Fuse 'windows'
61 Armament safety break panel
62 Aileron accumulator pressure gauges
63 Accumulator group bay
64 Plessey LTSA starter in lower (No. 1) engine nosecone
65 Lower (No. 1) engine intake
66 Wingrooot inboard fairing
67 Main equipment bay
68 Selector address unit
69 Electronic unit
70 Air data computer
71 Converter signal unit (datalink)
72 Communications T/R (two)
73 Canopy hinge
74 Dorsal spine bays
75 AC fuse and relay box (cold-air unit and water boiler to starboard)
76 28-Volt battery
77 Upper (No. 2) engine intake duct
78 Fuselage frames
79 Water heater tank and extractor
80 Wing/fuselage main attachment point
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85 ADEN gun muzzle
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89 Access
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93 Shuttle valve
94 Undercarriage strut fixed fairing
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97 Brake unit
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101 Aft fairing flap
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129 Flap outer actuator jack
130 Flap sections
131 Flap integral tank
132 Angled aft spar
133 Undercarriage attachment
134 Refuelling/defuelling valve
135 Flap inner actuator jack
136 Three-way cock (manual)
137 DC transfer pump
138 Gate valves
139 Wing/fuselage rear main attachment point
140 Lower (No. 1) engine intermediate jet pipe forward face
141 Wing inboard structure
142 Wing integral fuel
143 Intermediate spar booms (T-section)
144 Port ADEN cannon (forward ventral pack)
145 Wing rib stations
146 Fuel vent pipe
147 Multi-bolt wings attachment plate
148 Access panels
149 Upper (No. 2) engine duct frames
150 Fuselage break frame
151 Voltage regulators
152 Start tank
153 Engine pump units
154 Solenoid valves
155 Communications antenna
156 Starter control unit
157 HF igniter units
158 Fuselage frame
159 Main wing box upper skin
160 Forged centre rib (multi-bolt attachment)
161 Starter exhaust
162 Upper (No. 2) engine nosecone
163 Generator cooling ram-air intake
164 Stand-by generator
164 Anti-icing bleed air
166 Upper (No. 2) Avon 301 turbojet engine and reheat units
167 Airpass recorder unit
168 Engine front mounting point
169 Engine accessories
170 No. 2 engine bleed-air turbopump (reheat fuel)
171 Engine bay firewalls
172 Integral pumps (two)
173 HE ignition units
174 Voltage regulator

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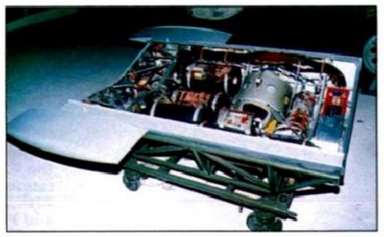
Lightning details



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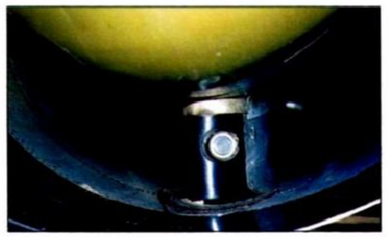

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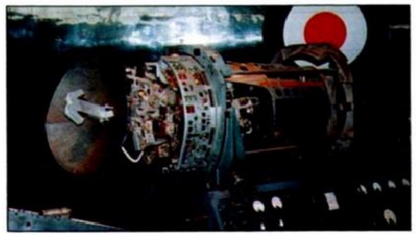

The AI.23 radar, seen here on a test rig, was necessarily compact in order to fit into the intake bullet fairing.

The refuelling probe was supported under the leading edge by a mount which incorporated a spotlight. The probe fed fuel into the rear of the wing tanks. The F.Mk 6's belly tank was arranged in three sections, of which the front could be replaced by the twin-ADEN cannon installation. The cannon installation was identified by blisters on the tank for venting the gun gases.

The refuelling probe was aligned just forward of the pilot, making it easy to see during tanking.

An emergency arrester hook was provided under the rear fuselage. A cut-out was required in the rear of the belly tank to accommodate it.

The 'saw-cut' wing notches were first introduced on the SB.5. They initially cured uneven flow over the ailerons without the need for a drag-inducing wing fence, but also provided other aerodynamic benefits at critical speeds.

Underneath this spine panel was the 3-Imp gal (13.6-litre) tank for the AVPIN starting system, along with associated starter control system and engine pump units.

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145 Wing rib stations
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149 Upper (No. 2) engine duct frames
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151 Voltage regulators
152 Start tank
153 Engine pump units
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155 Communications antenna
156 Starter control unit
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159 Main wing box upper skin
160 Forged centre rib (multi-bolt attachment)
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163 Generator cooling ram-air intake
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174 Voltage regulator
175 Current sensing unit
176 Rubber spring feel mechanism
177 Auxiliary intake
178 Main mounting trunnion
179 Aft (port) equipment bays
180 Electronic unit
181 IFF coder
182 Tailplane controls
183 Tailplane trim actuator and feel unit
184 Ventral fuel tank (aft section)
185 Fin
186 Reheat cooling lower intake
187 Tailplane autostabiliser actuator
188 Gearbox oil filler
189 AC generator
190 Glide-path receiver
191 IFF transmit/receive unit
192 Outlet
193 No. 2 engine intermediate jet pipe
194 Refrasil heat shrouds
195 Stress-bearing upper (No. 2) engine hatch
196 Port airbrake
197 Airbrake hydraulic actuator jack
198 DC generator
199 Main accessory-drive unit
200 Airbrake lower frame
201 Turbine exhaust (from 199)
202 Tailplane accumulator and nitrogen bottle
203 Reheat 'hotshot' igniter box
204 Tailplane drive triangular unit
205 Tailplane powered flying-control unit
206 Tailplane spigot
207 Pivot spar
208 All-moving tailplane
209 Light alloy honeycomb structure
210 Braking parachute box internally-retracting doors
211 Cable operating assembly
212 Fuselage aft frame
213 Lower (No. 1) engine reheat jet pipe
214 Trunnion access panel
215 AMCU air pipes
216 Reheat cooling upper intake
217 Rudder feel unit
218 Rudder trim actuator
219 Rudder autostabiliser actuator
220 Rudder linkage
221 Fin spar/fuselage bolts
222 Fuselage frame formers
223 Rudder powered flying-control unit
224 Reheat jet pipe mounting rail
225 Upper (No. 2) engine reheat jet pipe
226 Rear rollers
227 Air-driven nozzle actuator
228 Jet pipe trunnion access panel
229 Variable propelling nozzles
230 Streamer cable around rear lip (spring-clipped)
231 Parachute streaming anchor and jettison unit
232 Rudder light-alloy honeycomb structure
233 Flutter damper
234 Communications antenna
235 Dielectric tip
236 Compass unit
237 Angled aft spars
238 Main fin structure
239 Fin leading-edge panels
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241 Starboard aileron
242 Aileron powered flying-control units
243 Control linkage
244 Starboard flap outer actuator jack
245 Starboard flap
246 Wing panels
247 Wing skinning
248 Wing integral fuel
249 Aileron control push-pull tubes
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253 Glide-slope aerial
254 Underside view showing gun ports and Red Top missiles

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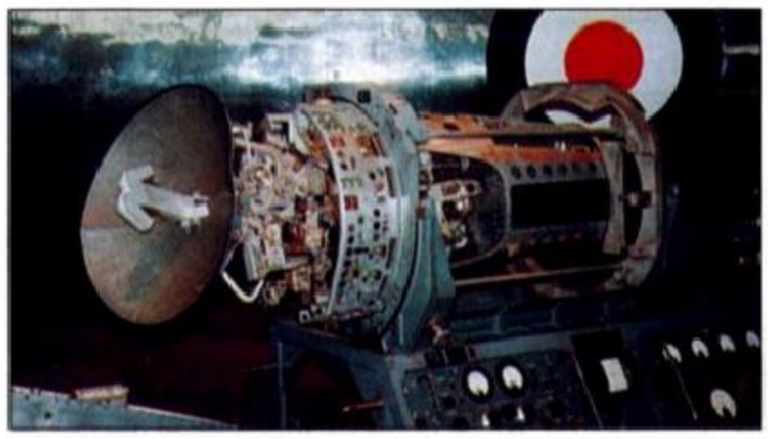

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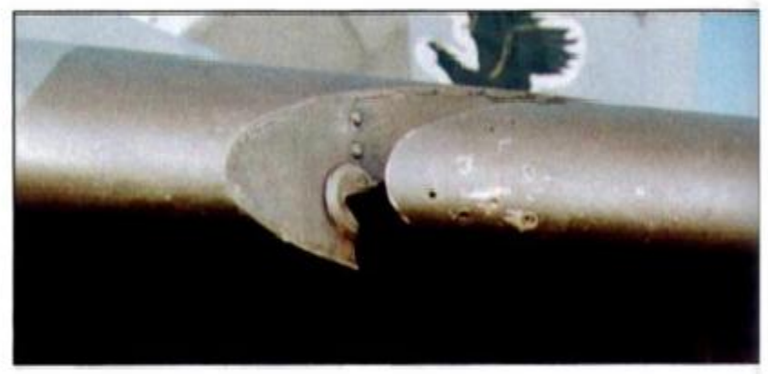


The 'saw-cut' wing notches were first introduced on the SB.5. They initially cured uneven flow over the ailerons without the need for a drag-inducing wing fence, but also provided other aerodynamic benefits at critical speeds.

Underneath this spine panel was the 3-Imp gal (13.6-litre) tank for the AVPIN starting system, along with associated starter control system and engine pump units.

244 Starboard flap outer actuator jack
245 Starboard flap
246 Wing panels
247 Wing skinning
248 Wing integral fuel
249 Aileron control push-pull tubes
250 Aileron movement restrictor
251 Aileron autostabiliser actuator
252 Starboard navigation light
253 Glide-slope aerial
254 Underside view showing gun ports and Red Top missiles

The nosewheel retracted forwards to lie in a well behind the intake splitter strut. On the P.1A it had to rotate through 90° to lie flat under the intake.

The forward-canted main undercarriage retracted outwards into wells in the outer wings, the strut rotating during the retraction sequence. The wheels were by necessity small and narrow, in turn requiring high-pressure tyres. Tyre bursts were commonplace.

Right: The Lightning F.Mk 6 cockpit was relatively uncluttered and was dominated by the attitude indicator and radio compass. At the top of the instrument panel was the rudimentary gunsight, with range setting dial, below which was the strip-type airspeed indicator. At top right was a standby magnetic compass and accelerometer, below which was the hood for the radar display. This could be folded and buttoned when not in use.

Mounting the engines one above the other (left) negated unpleasant asymmetric handling if one failed, but increased the likelihood of damage being incurred by the good engine. The engines were staggered, No. 1 being mounted well forward in the lower fuselage, although the afterburners for both engines were level. Engines were accessed and removed through upper and lower hatches, as demonstrated by this T.Mk 5 (right) undergoing engine tests, which were usually performed with the hatches open. An intake guard was fitted to prevent foreign object ingestion.

No. 23 Squadron was the stalwart of the Leuchars wing, acquiring F.Mk 6s (including a few Interim aircraft) in 1967. A highlight of the F.Mk 6 period was a non-stop two-ship deployment to Canada, and in early 1971 the unit became the first with the ventral gun pack.

Leuchars F.Mk 6

No. 74 Sqn (far right) was the first unit with the F.Mk 6, but it was at Leuchars only briefly, before being replaced by No. 11 Sqn, whose aircraft are seen below on the runway at Valley.

In the late 1960s Leuchars assumed ever greater importance as the number of Soviet patrol flights increased. It was natural that the base should be the first to get the long-range *(sic)* F.Mk 6 as it was tasked with covering a large volume of airspace to the north of the British Isles. Despite the extra fuel capacity, F.Mk 6s still required tanker support for the intercept mission.

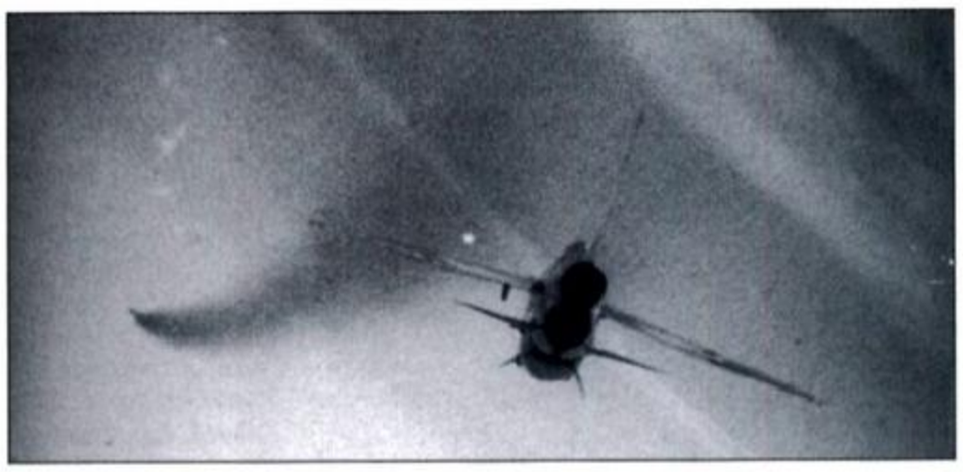
A classic shot depicts a Binbrook F.Mk 6 over its base. Following trials with a single-tone green aircraft, the grey/green disruptive paint scheme was adopted in the autumn of 1975, for camouflage on the ground.

Fox 4 – I was trying to get alongside, open my canopy, and club the son-of-a-bitch to death." On another occasion the Lightning was called upon to 'prove' its superior rate of climb over the F-15, following a TLP exercise. This was easy enough in the bar but, in point of fact, a fully laden F.Mk 6 was not capable of such a feat. Instead, a T.Mk 5 was stripped of all non-essential equipment (including the removable ventral tank) and was used for the contest. The Lightning passed the F-15 going through 2,000 ft (610 m), and streamed a Union Jack-bedecked brake chute upon landing.

In July 1979, a government announcement raised hopes of an even stronger resurgence in the Lightning force, since it stated an intention to establish a third operational Lightning squadron at Binbrook. Officially this was to have been No. 45 Squadron, although many hoped that by the time the new squadron stood up it would be No. 74 Squadron. Formation of a third squadron would have been relatively easy from the point of view of aircraft numbers, since some 80 Lightnings were in service or in store. Unfortunately, attaining the number of available pilots would have required considerable expenditure, and the new unit was cancelled before it could form. A cheaper solution was to form what was known as the Lightning Augmentation Force, which would have provided a third squadron only in time of war. This was achieved by running six courses per year with the LTF, during which all Lightning-qualified pilots occupying staff appointments of squadron leader rank or below returned to Binbrook for a week of ground school, simulator sorties and flying. This scheme proved popular and successful, but was soon axed as an economy measure. The LAF was not assigned its own aircraft, but LTF aircraft were sometimes marked up appropriately during LAF courses.

Notching up the quarter-century

August 1979 brought the 25th anniversary of the first flight of the P.1A, and in celebration a number of Binbrook Wing Lightnings were painted up in the markings of those squadrons which had re-equipped with F-4s, some of the aircraft being non-fliers rolled out of the storage hangars.



A gun camera still from a following aircraft provides a graphic image of an F.Mk 6 launching a missile. Against a live target it was standard practice to roll inverted and pull hard after missile launch to avoid the debris of the hit. Each new pilot had a chance to fire a Firestreak during the annual squadron MPC (missile practice camp). Flying was undertaken from Valley, with firing over the Aberporth range.

Poor weather unfortunately prevented the planned 25-aircraft flypast. Some of the repainted aircraft subsequently flew with their spurious squadron markings, confusing unwary onlookers for some weeks following.

Although the Leuchars-based Phantoms took the lion's share of the Northern QRA 'trade', the Lightnings at Binbrook continued to share the commitment. They regularly intercepted Soviet aircraft, some of which were deliberately probing the UK ADR to test reaction times, others merely transiting past the UK ADR en route to Cuba or Africa. By the late 1970s, only F.Mk 6s were used for QRA duties, almost always armed with Red Top rather than the older Firestreak missiles.

QRA came to symbolise life on the Lightning force, although, in truth, it was a duty which came around relatively infrequently for any one pilot. As soon as a pilot was declared limited combat ready he was judged qualified to stand QRA duty. The QRA commitment was usually shared between Leuchars and Binbrook, often with one station maintaining aircraft on QRA while the other did not.

Life on 'Q'

When a squadron was assigned to QRA duty, it would maintain a pair of aircraft at immediate readiness in a massive, corrugated-metal building known as the Q-shed, immediately adjacent to the runway threshold. The Q-shed was manned by 10 ground crew (who were usually assigned to the duty for 10 days or a week), eating and sleeping at the facility, eventually supported by specialist cooks. Both ground and aircrew had austere accommodation within the complex, with TV and books provided to help stave off the boredom on the long days when nothing happened. Two pilots would be assigned at any one time, standing 'Q' for 24 hours from 09.00 to 09.00. After officially taking over from the outgoing aircrew, the new pilots checked the alarm bells to air traffic control and to the ground crew, before inspecting their aircraft and setting up the cockpits to their individual preferences. The aircraft sat fully powered up, with all systems up and running that could do

Singapore sentries

In 1967 No. 74 Squadron undertook Operation Hydraulic, the move of its F.Mk 6s to Tengah to replace the Javelins of No. 64 Squadron. Leaving Leuchars on 4 June and routing via Akrotiri, Masirah and Gan, the squadron was operational again on 12 June. At the time it was the longest fighter movement and largest refuelling effort the RAF had undertaken, utilising the services of 17 Victors.

Carrying a wing commander's pennant below the cockpit and code-letter 'A', this is No. 23 Sqn's 'boss-bird' F.Mk 6, seen during a 1970s intercept of a Tu-95RT 'Bear-D'. By a simple fact of geography, the Northern QRA aircraft at Leuchars received the lion's share of live intercepts.

Below left: No. 74 took part in many air defence exercises in Southeast Asia and, on two occasions, visited Australia after a 2,000-mile non-stop flight.

Below: The 'Tigers' T.Mk 5 was shipped by sea to Singapore as the variant lacked the overwing tanks necessary to make the ferry flight.

Tupolev Tu-95 'Bears' and Tu-16 'Badgers', together with Il-38 'Mays', formed the bulk of the 'Zombie' trade, but occasionally the majestic Myasishchev M-4/3M 'Bison' would appear. This example is watched closely by a pair of No. 74 Sqn F.Mk 3s. The majority of these intercepts passed with good will, but on occasion the Soviets acted provocatively, especially during major NATO naval exercises when the stakes were higher and the seriousness of the situation was raised a few degrees.

Sounding the klaxon resulted in a headlong rush for the Q aircraft, demonstrated above by crews at Binbrook and right by No. 56 Sqn in Cyprus, where the Battle Flight aircraft operated from the line. Usually only one aircraft was launched. Aircraft were normally housed in the Q-sheds near the end of the runway, which were specially guarded. Below is the facility at Binbrook, while below right is the RAF Germany Battle Flight facility at Bruggen.

so without the engines themselves being started.

The pilots would sit in their rudimentary lounge, reading, doing their paperwork, watching TV, or chatting, all the while listening for the signal to scramble. It was impossible to forget that this might happen, since the wall-mounted speaker emitted a bleep every 30 seconds, just to confirm that it was on-line and working properly. It was connected directly to the relevant Sector Operations Centre, and often gave the first and only warning of an impending scramble.

Scramble warning

The call to scramble might come as a complete surprise, with the wall-mounted speaker crackling into life, but more often there would be some warning, as ground-based radars tracked the incoming 'Zombies'. Even with no notice whatever, the QRA Lightnings had to be able to be airborne within 10 minutes; six minutes was the informal time limit, with the aircraft taxiing within two minutes of the alarm. The need to react instantly meant that most pilots wore their full flying and immersion suits for their total 24-hour duty period, even while trying to snatch some sleep. Others accepted the delay imposed by struggling into an immersion suit in order to be more relaxed while waiting for the scramble.

When the scramble came, the pilots and ground crew sprinted to the aircraft, with the second pilot getting strapped in should the first aircraft fail to start. Sometimes an aircraft would be scrambled not to intercept a patrolling Soviet intruder, but instead to conduct a no-notice missile firing against a flare towed by a Jindivik or Meteor target drone. For most of the Lightning's career, each squadron was allocated six live missiles to be fired at the annual Missile Practice Camp at RAF Valley, with two more being allocated for operational firings mounted off a QRA scramble.

When the Cold War raged, live intercepts were always taken with utter seriousness. Since the aim was to intercept the enemy aircraft as far as possible from the UK, the Lightning often had to fly a very long transit, during which

QRA

In peacetime the Quick Reaction Alert was the most important role of the Lightning force. Two aircraft, known as 'Q1' and 'Q2', sat in special barns at the end of the runway, fully armed and fully fuelled, while the crews waited in flight gear for the call to action. Without having to align an INS like modern interceptors, the Lightnings were often airborne in under three minutes, but the radar needed at least five to warm up, this task being completed in the air while the pilot followed GCI vectors to the 'Zombie'. In Germany and Cyprus the 'Q' drill was known as Battle Flight.

Cyprus guardians

Between 1967 and 1975 British interests in the Mediterranean were protected by the Lightnings of No. 56 Squadron from Akrotiri. Soon after the 13 F.Mk 3s and single T.Mk 5 arrived they were on full alert during the Turkish invasion of northern Cyprus. In December 1974 further clashes between Greek and Turkish factions saw the squadron, by then equipped with F.Mk 6s, back on intensive combat air patrol duties.

tanker support was essential. At any point in the sortie, the Lightning had to have sufficient fuel to be able to reach a diversion airfield, and until the QRA aircraft had successfully refuelled for the first time the second QRA pilot would be held at cockpit readiness. The Lightning (and its tanker, usually a Victor) would be guided to the 'Zombie' by GCI radar, with the Lightning able to acquire a 'Bear'-sized target at ranges of up to 60 miles (96 km) from the beam, and able to get a 'visual' at up to 20 miles (32 km). Having taken position on the port station of the target aircraft, the Lightning pilot would then be expected to take large numbers of photos of the 'enemy' aircraft, in order to glean maximum intelligence value from the encounter. Usually at high level, the target aircraft might fly very slowly, forcing the Lightning pilot to fly close to the stall. Sometimes Soviet aircraft turned sharply towards the escorting Lightning, forcing it to take avoiding action. At night, Soviet aircrew even shone bright lights at the Lightnings' cockpits, trying to dazzle their interceptors.

There were friendly gestures, too. Many Soviet crewmen waved, showed bottles of Pepsi (or vodka) and even copies of *Playboy*. Others mimed drinking, and most would smile rather than scowl. Occasionally, the Soviets would even co-operate or help. When one No. 11 Squadron pilot escorting a 'Bear' found his tanker gone, low on fuel and unable to raise it on radio, about to divert to Keflavik, a heavily accented Russian voice interrupted in broken English to give an accurate range and bearing to the tanker, wishing him "English Electric MiG, Bon Voyage."

'Zombie' decline

During the Binbrook era, encounters with real Soviet aircraft became progressively less common, and many pilots passed an entire tour without being scrambled to intercept one. Once a pilot had successfully intercepted a 'Bear' or 'Badger' he would normally become the Q2 pilot (the second pilot) when standing QRA, scrambling only if more trade appeared while the first pilot was airborne. This was an increasingly rare occurrence.

Landing after a QRA scramble, the pilot would write up his reports and return to QRA (usually Q2) status for the remainder of the 24-hour period. The aircraft would then be refuelled and turned around, ready to scramble again if necessary, or might be replaced by another fully-armed and fuelled Lightning.

In 1982, the Lightning force played a vital, if unsung, role in Operation Corporate, the British mission to recapture the Falkland Islands after they had been invaded by Argentina. The Lightnings were used to provide Mirage III surrogates for dissimilar air combat training for British aircraft which were deploying to the South Atlantic, especially the RAF Harrier GR.Mk 3s. Some Lightnings even began using the long-range overwing fuel tanks again, although there were never any plans to send the Lightnings 'down South'.

During the late 1970s and early 1980s, the Lightnings began to suffer a series of fatigue problems. Unexplained fin skin damage was eventually attributed to the effect of the

Above: Brake chute, wheelbrakes and airbrakes all combine to slow an F.Mk 6 on the Akrotiri runway.

Above left: After leaving rain-soaked Wattisham, ground crew soon got used to working in the Mediterranean sun.

Right: No. 56 Sqn was a regular visitor to the base at Luqa. Note the white spine panels.

Capturing the last remnants of a dying era, this photo shows a khaki-clad mounted MP greeting a returning 'Firebirds' pilot. When No. 56 Sqn left Cyprus for Wattisham in January 1975, the last of the great colonial deployments, and a long chapter in the RAF's history, had come to an end.

Binbrook Wing

Binbrook's association with the Lightning began in October 1962, when the AFDS moved in from Coltishall, but it was not until three years later that a front-line unit, No. 5 Sqn, was based there. No. 11 moved south from Leuchars in 1972 and, as other units converted to the Phantom, Binbrook became the sole Lightning base for over a decade, absorbing the training function from 1974.

Above and left: Two formations show aircraft from the Binbrook Wing units, in both cases the LTF leading Nos 5 and 11 Squadrons.

Right: Lightnings continued to be common sights at Akrotiri long after No. 56 Sqn returned home. This No. 5 Sqn aircraft is seen during an APC, the area round its cannon muzzles blackened from firing.

jet wash from Vulcan tankers, while other minor problems were simply due to old age and hard use. A wingroot strengthening programme was initiated in 1979, which ran until 1983 and covered most of the surviving F.Mk 6s and T.Mk 5s. The F.Mk 3s were not modified, since they had shorter service lives remaining and since, as lighter aircraft, they had been less badly affected. In 1985 BAe put 35 Lightning F.Mk 6s through the Mod 9 programme, which effectively added 400 flying hours to the life of each modified aircraft. These Lightnings provided the Binbrook wing with its core aircraft until the final retirement three years later, although three of the modified machines were lost in accidents.

Saudi retirements

Saudi Arabia retired the last of its Lightnings before the RAF did, replacing them with newly purchased F-15 Eagles. The last Saudi Lightnings ceased flying in December 1985, by which time BAe had agreed to buy back the best of the survivors. On 14 January 1986, Binbrook's pilots ferried a first wave of 12 ex-Saudi Lightnings back to Warton, ferrying another 10 back one week later and completing their part in Operation Dhonanyi. For their ferry flights back to the UK, the aircraft had their Saudi insignia and serials removed, and small British insignia and serials in the range ZF577-ZF598 were applied. Hopes that these aircraft might be used to form a third Lightning squadron were soon dashed, when it was revealed that their repurchase had been part of the Saudi Al Yamamah Tornado purchase, and that BAe had a specific customer in mind for the aircraft. This was almost certainly the Austrian air force, which reportedly preferred the Lightning to the alternative of ex-Swedish Saab J35 Drakens. In the end, though, politics dictated that neutral Austria would purchase its fighters from neutral Sweden. The aircraft were also offered to Nigeria, which sent officers to Binbrook to witness Lightning operations and conversion training at first hand. A brochure was prepared showing the aircraft armed with four AIM-9L Sidewinder missiles, one above and one below each Firestreak/Red Top pylon.

The RAF itself reportedly cast covetous eyes on the four T.Mk 55s recovered from Saudi Arabia. With their big cambered wing and large ventral tank they would have been ideal for training F.Mk 6 pilots, but they were judged to be too different from a technical standpoint and so remained in storage at Warton. Unfortunately, the Saudi aircraft failed to attract a buyer, and were destined never to fly again. They were inadequately inhibited and deteriorated rapidly, and were eventually disposed of to museums and collectors. Two F.Mk 52s remain on display in Saudi Arabia, at Dhahran and Riyadh, with a T.Mk 54 at Dhahran and single F.Mk 53s at Khamis Mushait and Tabuk.

In 1986, No. 5 Squadron celebrated its 70th anniversary, which by happy coincidence also marked 21 years of service with the Lightning (all with the F.Mk 6 as the primary variant). To mark the occasion, the CO's aircraft received a red fin, spine and wing leading edges, and the squadron flew a celebratory flypast, although poor weather and low cloud ensured that only the participants witnessed the spectacle.

1987 was the last 'normal' year of operations for the Binbrook wing. The Lightning Training Flight disbanded in April 1987, having failed all five students on the last long course (at least three went on to successfully fly Phantoms or Tornados in the air defence role, demonstrating how much more demanding the Lightning was). The LTF celebrated its disbandment with an eight-aircraft flypast and a 'beat-up' of Binbrook, which drew from the station commander (flying as No. 4 in the formation) the comment "I knew we should have practised that," to which the LTF's CO responded with "I didn't think you'd let us do it

Below right: In 1984 three No. 5 Squadron aircraft received sharksmouth markings during an APC at Akrotiri.

Below: A No. 11 Sqn F.Mk 6 nuzzles in close for the camera. From 1971 the F.Mk 6 received a belly tank modification which reinstated gun armament, albeit at a slight penalty in fuel capacity. The gun became increasingly important as a weapon as the Lightning aged and its missiles became ever more obsolete. The guns were harmonised to fire at 450 yd (411 m), which was ideal for fighter targets. However, this put the aircraft well within the range of the fearsome 23-mm tail guns of Soviet bombers.

twice, sir." The end of the LTF meant retirement for the F.Mk 3, although two aircraft were briefly 'kept on' by No. 5 Squadron for the final aerobatic display season. This was flown by Flight Lieutenant Jon Fynes, and consisted of 42 displays spread over the season. For the first time, fatigue was not a consideration, and the Lightnings were flown to the type's 6-*g* limit as a matter of routine. The aircraft were inevitably flown with Firestreak airframes, since they generated significant lift, improving turn performance and enhancing the handling characteristics.

Despite the lack of limits, both F.Mk 3s survived the 1987 air show season, bowing out at what was billed as the 'Last, Last Lightning Show'. A previous No. 5 Squadron display pilot had been less lucky, being forced to eject from a borrowed LTF F.Mk 3 when it entered an inverted spin over Binbrook. After divesting himself of his parachute the officer rang the LTF's commanding officer with the immortal words "That aircraft is u/s [unserviceable], sir, can I have another one?"

Missiles galore

1987 was the last year in which the Lightnings undertook Missile Practice Camps, which were veritable 'firefests' in which large numbers of soon-to-be-redundant missiles were available for firing. In August 1987, No. 5 Squadron fired 23 missiles, with No. 11 firing 17 more in September. As a minor footnote to the Lightning story, September also saw the last flight of the Empire Test Pilots' School's Lightning T.Mk 5. Rolls-Royce ceased overhauling Lightning Avons during the year, which caused some difficulties, although enough engines existed to support the remaining airworthy airframes. Engines had a 600-hour life between overhauls, while the airframes were routinely serviced every 75 hours, with a major (a servicing which took 30 weeks) every 500 hours. Binbrook's engineers completed their last major in mid-1987. At the rain-soaked 'Last, Last Lightning Show', the two squadrons put up a diamond nine formation, led by Station Commander Group Captain John Spencer. It was the last opportunity for the public to see a Lightning formation display. The end was clearly near.

No. 5 Squadron officially stood down on 31 October, but hosted a reunion of former members on 7 November, flying a nine-aircraft formation for the benefit of the camera. The squadron flew its last operational Lightning on 10 December and passed some of its aircraft, and four of the younger pilots, to No. 11 Squadron. The final disbandment left No. 11 Squadron as the RAF's last Lightning unit, and the rundown of Lightning operations at Binbrook began in earnest, though the unit continued to fly operational sorties. Even as late as January 1988, No. 11 Squadron sent four F.Mk 6s and a T.Mk 5 to Gütersloh for dissimilar air combat training with the based Harriers. With plenty of airframes remaining the race was on to use up the remaining fatigue before the aircraft were withdrawn, and the last Lightning pilots found themselves in the fortunate position of being able to fly far more high-*g* air combat sorties than had been possible in the past. Spares were plentiful as a result of the disbandment of No. 5 Squadron, and the avail-

Inflight refuelling was an everyday task for the Lightning pilot, being vital to the air defence mission. There were no special techniques required, the Lightnings formating on the port wing before dropping back on to the drogue, which had traffic light signals. The final approach was made at 'a stiff walking pace', and after the drogue had been pushed in 6 ft (1.83 m) fuel would begin to flow. If two aircraft refuelled at the same time, the starboard aircraft would plug in first. In the beginning of the Lightning's career the Valiant was the main tanker, replaced from 1965 by the Victor. In the early 1980s the single-point Vulcan K.Mk 2 (above left) was briefly used, while from 1984 the VC10 (above) assumed ever-greater importance.

Lightning Training Flight

When 226 OCU was disbanded as a cost-saving measure the continuing demands of providing Lightning type training were underestimated. For a short while the task was subsumed into No. 11 Squadron's tasking, for which 'C' Flight was formed, but the training effort proved to be too big for such an organisation. Accordingly, the autonomous Lightning Conversion Unit was formed in September 1974, this becoming the LTF in October 1975. Lightning training came to an end in April 1987.

The Lightning Training Flight (tailcode 'Dx') mainly operated the T.Mk 5 (left) and F.Mk 3, although a handful of F.Mk 6s were assigned, including one usually operated as an intercept target. The F.Mk 6 shown above carries the late LTF markings but has non-standard tailcodes for the last Binbrook station commander, Group Captain John Spencer.

The ETPS greatly valued the Lightning as a test pilot training aid due to its side-by-side seating. The aircraft acquired its red spine shortly after it arrived at the unit. The preceding T.Mk 4 had worn the codes '23' throughout its tenure at Boscombe Down.

ability of more airframes to cannibalise. Similarly, it had been clear for some time that the RAF's stock of Firestreak and Red Top missiles would have no useful life following the retirement of the Lightning, and this had led to a further increase in the number allocated to each squadron for firing each year.

There were some hopes that the Lightnings might find a new role as unmanned target drones after their retirement from front-line service, but in the end the aircraft's tricky handling characteristics, high approach speed and reliance on a brake parachute ruled it out. More significantly, Binbrook's engineers had done their job too well, and hardly any of the airframes had adequate fatigue life remaining for conversion to be a viable proposition. Thus, as No. 11 Squadron's disbandment drew closer, it became clear that most remaining Lightnings would be scrapped, sent to serve as decoys or BDRT airframes, or retired to museum or gate guard use.

For pilots and onlookers alike, it was the phenomenal rate of climb for which the Lightning is best-remembered. A pressure suit was available but was virtually never used as it was very uncomfortable, although this did not prevent Lightnings regularly topping 60,000 ft (18290 m). On one decidedly unofficial flight a Lightning allegedly reached 78,000 ft (23775 m), at which height the aircraft was virtually ballistic.

Far right: Seen on a wintry day at Binbrook is one of No. 11 Sqn's surviving F.Mk 3s. The best of the lightweight Lightnings were retained at Binbrook for training with the LTF, and by the two front-line units for target work. They were also the favoured mounts for air display work.

Empire Test Pilots' School

Based at Boscombe Down, the ETPS uses a wide variety of aircraft types for the training of test pilots. For many years the Lightning provided the supersonic equipment, T.Mk 4 XL629 being used between 1966 and 1976 before being replaced by T.Mk 5 XS422, which was flown until 1987/88, by which time a Tornado F.Mk 2 had been allocated. The T.Mk 4 is now on display at Boscombe's main gate.

The RAF's last flights

As No. 11 Squadron's last pilots were posted out (mostly to Coningsby, to convert to the Tornado), those remaining found themselves tasked with delivering their aircraft to their final resting places. Although this was a duty tinged with sadness, there were some bright moments, and some opportunities for final displays of exactly what the Lightning could do. When arriving at their destinations, many a pilot found himself having to make runs down the runway to clear vehicles away, or having to make several approaches and low overshoots, often using reheat to burn off unneeded fuel (the Lightning had no fuel dump). These were not unauthorised displays, of course, since such displays would have contravened regulations. No. 11 Squadron flew a last diamond nine formation on 29 April, and formally down-declared and stood down on 30 April 1988, relinquishing all operational duties. Its identity was then taken over by a new No. 11 Squadron converting to the Tornado F.Mk 3 at RAF Coningsby. From 25 May, Squadron Leader John Aldington, the former OC 'B' Flight, took over as CO of the depleted squadron, eventually gaining the honour of making the RAF's very last Lightning flight. The run-down of what became the squadron's Lightning element lasted into July 1988, with the last two aircraft leaving on 30 June 1988, the very day that the Tornado unit formally reformed at Leeming.

Even after No. 11 Squadron finally closed its doors, the Lightning lived on. Continuing troubles with the Tornado

Lightning Augmentation Flight

When plans to form a third Lightning squadron at Binbrook failed to materialise, the LAF was formed to keep former Lightning aircrew current. Binbrook's two front-line squadrons drew aircraft from a large pool to equalise fatigue use across the fleet, leaving many usable aircraft in store. The LAF ensured there was a ready supply of current pilots to fly the stored aircraft should they ever have been required.

Although not assigned aircraft directly, the LAF applied its diamond badge to aircraft borrowed from the other Binbrook units, such as this F.Mk 3.

ADV's radar had provided No. 11 Squadron with an interesting task for the last months of its existence, that of providing targets for test Tornados (and a Foxhunter-equipped Buccaneer) to track over the Aberporth range. The aircraft involved in the trials (F.Mk 6s XR724, XR773, XS904, XS928) were among six Lightnings refurbished and fitted with the Lightning's distinctive overwing fuel tanks. This restricted them to subsonic speed, but dramatically increased endurance. In fact, in 'ferry configuration' the Lightning could outlast a 'clean' Tornado F.Mk 2. By March 1988 the tank-equipped Lightnings had been transferred from the RAF to BAe, and continued to be flown by BAe pilots, alongside the company's existing F.Mk 6 XP693, which had been a long-serving trials and high-speed chase aircraft.

Radar target missions

It had originally been hoped that the Foxhunter development programme would last about two years, but in fact the Lightnings transferred to BAe soldiered on for nearly five. XR724 actually ran out of fatigue life during the project. That was not the end for '724, though, since it was delivered to RAF Shawbury for storage on 27 July 1990, and then to Binbrook, where the aircraft is maintained in taxiing condition. It was replaced in Foxhunter duties by XR773, which joined the programme from storage at Boscombe Down. Sometimes the Lightnings flew with their tanks ('Overburgers'), and sometimes (for supersonic target work) without. With the overwing tanks fitted, it was discovered that the Lightnings closely resembled the 'Backfire' in radar cross-section, making them particularly representative of the types of target which the Tornado ADV might have to intercept. Their endurance was frequently extended by refuelling from Warton's buddy tank-equipped Buccaneer, XN974. As the Tornado radar got closer and closer to spec, the Lightnings had their own radar scanners inhibited to prevent them 'blinking' and to allow the Lightnings to present a more regular and constant signature.

By the time it finally retired, the Lightning was an obsolete anachronism, barely capable of fulfilling an operational role. Its engineers and technicians laboured long and hard to keep a handful of their veteran charges on the flight line, hampered by structural tiredness, spares shortages and a host of traditional Lightning problems that had never been solved, from inadequate accessibility to unreliable systems and a notorious propensity to catch fire. If the Lightning's introduction can be remembered as a gloriously optimistic summer of sparkling, highly-polished, high-tech silver fighters, gaily bedecked with gaudy squadron insignia, thundering skyward from leafy Coltishall, then its lingering death was summed up by a dull, hazy, rainy spring (it should have been autumn, or winter) of mist and low cloud at bleak, windswept Binbrook, with tatty matt-painted museum pieces dripping fuel, oil and other vital fluids onto

Top: The swollen front end of the T.Mk 5 led to it being nicknamed the 'Tub'.

Above: Permanent trials aircraft XP693 retained its natural metal finish throughout its long life, although it gained spurious squadron markings on at least two occasions to help units celebrate anniversaries. Here it partners No. 65 Squadron's 75th anniversary-bird Tornado F.Mk 3 for a 1991 photo-shoot. No. 65 was the shadow squadron number of the Tornado interceptor OCU at the time.

Air defence grey

From August 1981 Lightnings began appearing in a variety of air defence grey colour schemes, based on two colour mixes. The first (seen below on the nearmost two aircraft) consisted of semi-matt Dark Sea Grey upper surfaces, semi-matt Medium Sea Grey lower fuselage and semi-matt 'Barley' Grey under the wings. The other colour mix (left) employed just the two lighter shades.

Right: An F.Mk 6 carries a live Red Top missile. Like the Firestreak, the Red Top had a swivelling infra-red telescope behind the glass dome for long-range acquisition of the target.

Far right: XN795 remained on trials duties all its life. Here it is seen in F.Mk 2A configuration at RAE Bedford, from where it flew in the late 1970s on trials with the 27-mm Mauser cannon developed for the Tornado. It then returned to Warton as a chaseplane.

the dull grey tarmac.

At the end of the day, though, the Lightning lacked the range and the autonomous operating capability to be much more than a point defence interceptor, and even then lacked the weaponry to engage targets with sufficient stand-off range. It had been severely limited and constrained even when it entered service. The Lightning's failings were camouflaged, to an extent, by its successes in peacetime DACM training engagements, and by the skill of its superbly trained and often veteran pilots. In a close-in manoeuvring fight the Lightning remained a difficult foe until the very end (even for an F-16 pilot), until the Lightning pilot had to break off the fight and streak for home, gasping for fuel. And fuel was extremely limited. "All attacks were a once-only affair, you had to get it right first go. There wasn't the fuel for a second attempt," said the RAF's last pilot to convert to the Lightning, Flight Lieutenant Ian Black.

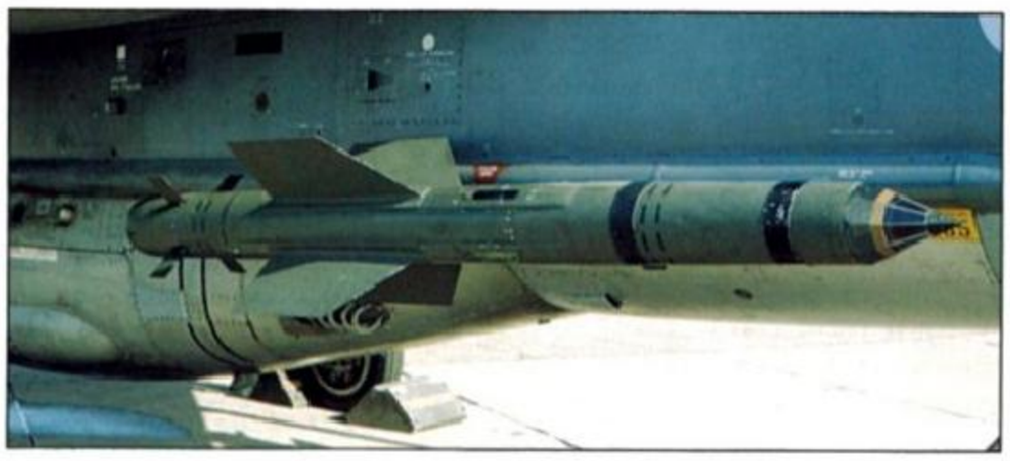
All versions of Lightning could carry the Firestreak and, despite its tailchase-only limitations, was such a reliable weapon that it was kept in service alongside the more sophisticated Red Top. Both missiles required a large onboard support package in the weapons pack, unlike the AIM-9 Sidewinder which could have been fitted to the Lightning at very little expense but would have provided a great leap in capability.

The Lightning was mourned by its pilots, who knew that they would miss its exhilarating performance, and by countless enthusiasts for whom the retirement of the Lightning marked the end of an era. But even at Binbrook, the Lightning's last outpost, few pilots would have shed a tear if they had been able to trade in their mounts for a modern single-seater like the F-15, F-16 or F/A-18. Some even welcomed the prospect of converting to the two-seat Tornado ADV, despite the problems then being suffered by that aircraft.

Even with its lack of fuel and modern sensors, avionics, defensive systems, and weapons, the Lightning will long be missed for its performance. Many a Tornado F.Mk 3 pilot has found himself unable to keep up with a high-level 'Bear' or 'Badger' travelling flat out, or unable to tank above 20,000 ft (6096 m) without using reheat, situations which would have been inconceivable in the Lightning. With the type's retirement the RAF was left without an agile, high-energy air superiority fighter capable of meeting enemy single-seat fighters on equal terms; the F-4 and Tornado F.Mk 3 were highly effective BVR bomber-destroyers, but not air superiority fighters in the true sense. It was once hoped that the Agile Combat Aircraft (later EFA) would fly in 1986 and enter service in about 1995, leaving only (!) a seven-year gap in vital air defence capability. It now seems likely that it will be 2004 at the earliest before a squadron pilot gets his hands on the Eurofighter – 16 years after the retirement of the RAF's last single-seat fighter. Hopefully, it will be worth the wait.

Proposals

The Lightning had finally had its day, but it need not have been so. Throughout its career, the Lightning was dogged by a lack of development and investment. Born as an interim fighter to cover the anticipated brief period before missiles took over the manned fighter's role, no-one was ever able to provide the (relatively modest) funding that would have been required to turn the aircraft into a truly effective fighter. A more easily manageable radar could have trebled combat effectiveness by reducing pilot



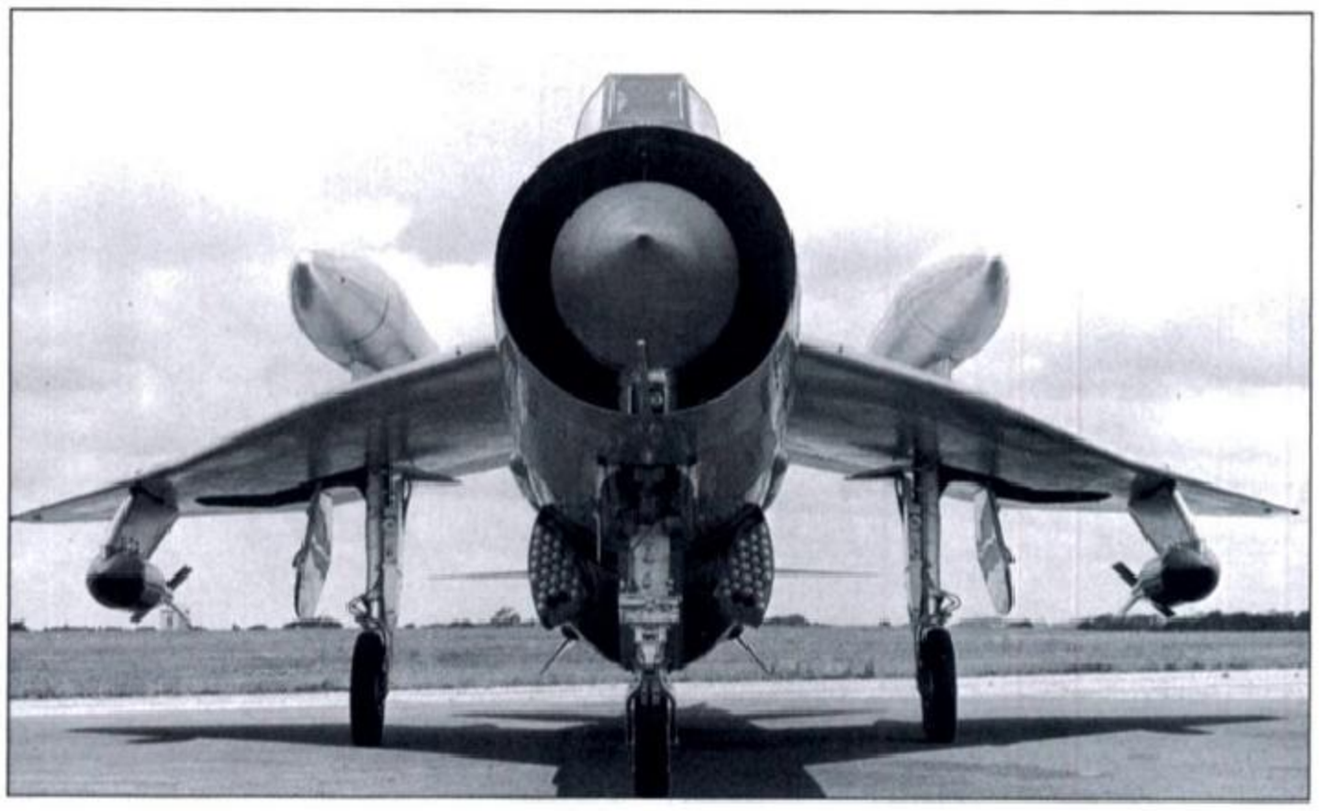
Left: The Red Top was based on the Firestreak, but incorporated a primitive all-aspect seeker. In a head-on engagement the missile had to be aimed well ahead of the target to stand a chance, and was only really effective in this mode against supersonic targets.

Lightning weapons

Most development centred on air-to-air weapons, including the missiles, cannon and drop-down unguided rocket packs. The latter were later used for ground attack work, augmented by rocket pods and bomb-dropping capability developed only for the export version.

A BAC trials aircraft is seen fitted with the underwing pylons of the F.Mk 53, which could carry 1,000-lb bombs or MATRA pods (illustrated), each of which carried 18 68-mm SNEB rockets.

Below: In addition to the 1,000-lb (454-kg) bombs, this F.Mk 53 displays the 22-weapon drop-down housings for 2-in (5-cm) Microcell rockets. This was a weapon pack option, displacing missiles or the lower guns, and had originally been intended for area saturation of large bomber targets, although was later to find an application in the ground attack role. The installation was tested by DB aircraft XG313 from 1960.



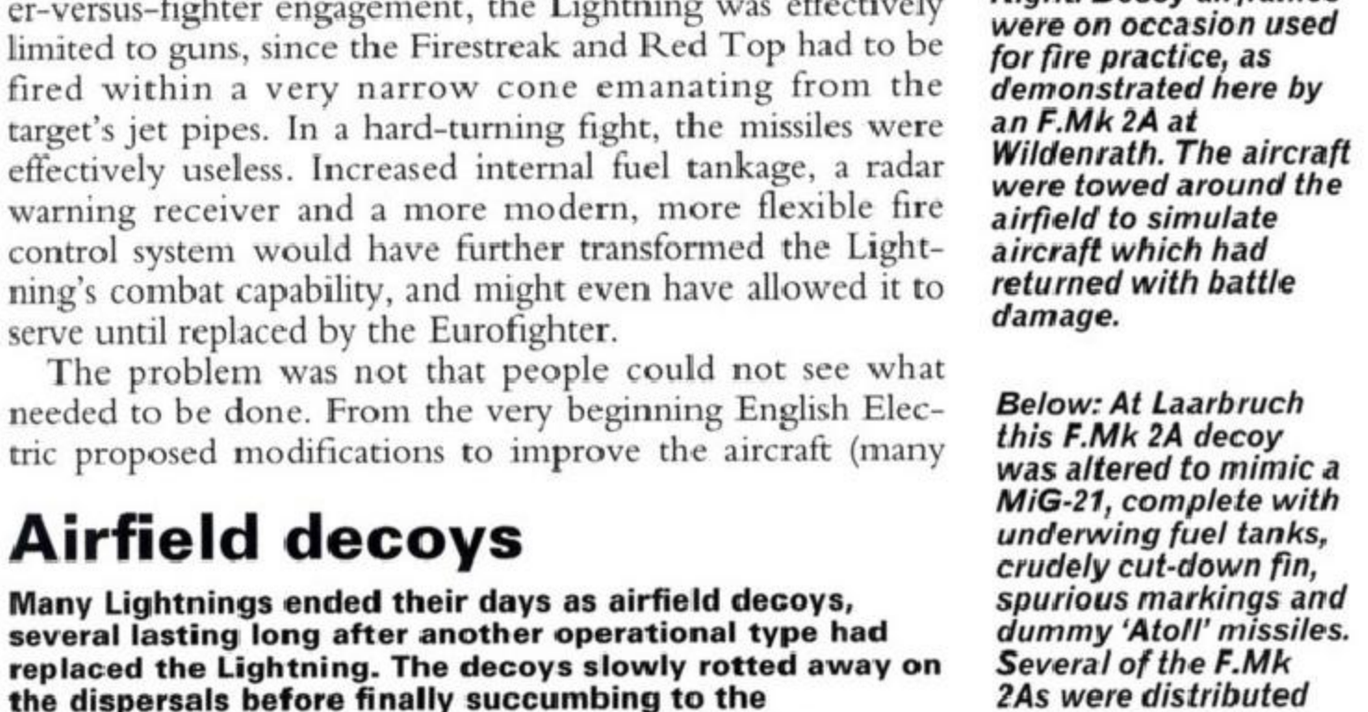
workload. Even the provision of AIM-9 Sidewinder missiles would have made a huge difference, and four could have been accommodated on twin launcher rails on the forward fuselage pylons without undue effort, perhaps with two or four more underwing, overwing or on wingtip rails. There were plenty of studies, and one No. 11 Squadron F.Mk 3 was even mocked up with Sidewinders at RAF Valley during a 1982 MPC deployment. An operational AIM-9 fit would not have been much more difficult to achieve, but the money was never there. In a typical fighter-versus-fighter engagement, the Lightning was effectively limited to guns, since the Firestreak and Red Top had to be fired within a very narrow cone emanating from the target's jet pipes. In a hard-turning fight, the missiles were effectively useless. Increased internal fuel tankage, a radar warning receiver and a more modern, more flexible fire control system would have further transformed the Lightning's combat capability, and might even have allowed it to serve until replaced by the Eurofighter.

The problem was not that people could not see what needed to be done. From the very beginning English Electric proposed modifications to improve the aircraft (many of which found a home in the export variant for Saudi Arabia and Kuwait, as described), but also proposed a whole range of advanced Lightning derivatives, none of which got further than the drawing board. In the very early days of the project English Electric sketched the P.8, recognising the likelihood that the Lightning would one day have to counter low-level supersonic bombers operating with ECM support. Based on the P.1 with an area-ruled fuselage, extended-span wings and cambered leading edges,

On the eve of the unit's disbandment – and the end of Lightning operations in the RAF – No. 11 Squadron put up this fine nine-ship on 29 April 1988. Led by the CO's black-tailed aircraft, the formation also contains the Binbrook flagship.

Airfield decoys

Many Lightnings ended their days as airfield decoys, several lasting long after another operational type had replaced the Lightning. The decoys slowly rotted away on the dispersals before finally succumbing to the scrapman's torch. Occasionally the airframes were brought into use for other duties, notably during base emergency exercises.



Above: This F.Mk 1A received the grey/green camouflage for its decoy duties at Wattisham.

Right: Decoy airframes were on occasion used for fire practice, as demonstrated here by an F.Mk 2A at Wildenrath. The aircraft were towed around the airfield to simulate aircraft which had returned with battle damage.

Below: At Laarbruch this F.Mk 2A decoy was altered to mimic a MiG-21, complete with underwing fuel tanks, crudely cut-down fin, spurious markings and dummy 'Atoll' missiles. Several of the F.Mk 2As were distributed around RAF Germany bases after their front-line days were over.

Below: In 1975 this Binbrook F.Mk 1 decoy was used as a canvas for an experimental grey paint scheme.

English Electric Lightning

The end is nigh: two Lightning F.Mk 6s from the 'old' No. 11 Squadron escort a Tornado F.Mk 3 from the 'new' No. 11 (Designate) Squadron, which stood up at Leeming to work up on the new fighter even while the Lightning continued to serve at Binbrook. What the Tornado lacked in glamour and outright performance, it more than made up for in almost all other areas, especially weapons system, missiles, radar and navigation. Of course, the new-found technology required a second crew member to operate it – a fact played on mercilessly by old Lightning pilots.

the P.8 was optimised for autonomous operation and had two crew sitting in tandem. The undercarriage was moved to area-ruled bulges on the rear fuselage, allowing the entire wing to become a giant integral tank. The RB.126 engines had convergent/divergent nozzles and the aircraft's missile armament was carried on wingtip launch rails. The P.8's great misfortune was to emerge shortly before the 1957 Defence White Paper.

The P.15 was a more modest February 1956 development of the Lightning intended for the reconnaissance role, and similar, in fact, to the later F.Mk 53's optional reconnaissance installation. The P.18 was a low-level fighter-bomber design drawn up in the autumn of 1956, while the P.19 designation was assigned to a fighter more advanced than the F.Mk 6. A two-seat strike fighter design of late 1959 was known as the P.33 and was based on the T.Mk 5. The P.34 was another advanced strike fighter, a single-seater for the RAF, loosely based on the F.Mk 2.

The P.33 was designed for the Royal Australian Air Force, and was probably the first Lightning to feature the extended ventral tank test flown on XA847 and XN725. It was proposed that the aircraft would have more advanced navigation and weapons systems, including Decca Doppler, with up to four AIM-9 Sidewinders and a range of ground attack stores, including Bullpup ASMs.

The cancellation of TSR.2 (and a number of other vital British projects) did not fatally damage the British aircraft industry, and a crop of further Lightning derivatives emerged during the late 1960s. Within English Electric and BAC, the T.Mk 5 (and especially the T.Mk 55) was perceived to have enormous operational potential; its two seats and increased fuel could have been able to turn the Lightning into a genuinely multi-role aircraft in the mould of the F-4 Phantom, whose export success was being watched with some envy. It was not unexpected that the advanced Lightnings proposed in the later 1960s were based on the T.Mk 55, but it was surprising that they were designed to meet a Royal Navy requirement (AW406) for a supersonic fleet air defence, reconnaissance and strike aircraft. This was the requirement written around the ill-fated Hawker P.1154 (the supersonic two-seat Harrier) and eventually fulfilled by the separate purchases of Phantoms and (subsonic) Mk 2 Buccaneers.

Naval versions

BAC initially proposed a fairly 'minimum change' version of the T.Mk 55, with a further extended ventral tank, and increased fuel capacity in the wings. This gave a total internal fuel capacity of 1,300 Imp gal (5910 litres). The aircraft was fitted with an arrester hook, a tail skid, and a restressed undercarriage capable of absorbing a sink rate of 20 ft/sec, and at its maximum all-up weight of 47,000 lb (21320 kg) could carry four 1,000-lb (454-kg) bombs underwing.

BAC also proposed a more radically modified navalised Lightning. The aircraft was given a new radar, based on AI.23B, but with a much larger 30-in (76-cm) diameter dish. To enhance approach and low-speed performance and handling, the aircraft gained a variable-geometry wing with the pivots well outboard, much like the Su-17. Wingspan was 48 ft 2 in (14.68 m) with the wings swept forward, and 36 ft 7 in (11.15 m) when fully swept. The undercarriage was repositioned further inboard, retracting forwards and inwards into the fixed portion of the wing. To reduce overall height on the ground (and to allow easier stowage on a carrier's hangar deck) the tailfin was given a folding tip. The variant was powered by a pair of new RB.168/1R engines, 'fed' by separate ducts, with new 'cheek'-mounted intakes featuring variable ramps and boundary layer bleed. Fuel capacity was increased to 2,000 Imp gal (9090 litres), giving a range in the strike role of 825 nm (948 miles; 1525 km), and maximum all-up weight rose to 47,450 lb (21525 kg) with four 1,000-lb (454-kg), or 44,950 lb (20390 kg) in the air-to-air role, with four Red Tops. At maximum weight, wind over deck required was 24 kt (27 mph; 44 km/h).

BAC got as far as planning a development programme for this advanced navalised Lightning. Two aircraft were to have flown with the wing in the swept forward position, with a third prototype testing a fully functioning wing. Despite strong Admiralty support, the programme was eventually axed.

The last remaining Lightnings were grounded and dispersed, although not before the final three were flown

In their last years of operations both Binbrook squadrons painted their flagships with coloured tails, No. 5 adopting a red tail (right) and No. 11 black (above). In its last days the Lightning was still a capable airframe, let down by its woefully inadequate systems. A key area never addressed was defensive systems: the aircraft had no RWR, relying instead on the quick wits and sharp eyes of its pilots, and coverage provided by air defence radars.

BAe radar target fleet

British Aerospace, and its BAC and EECo forerunners, had used many Lightnings for test and chase work, and in the last years maintained a five-aircraft fleet to act as targets for the Foxhunter radar of the Tornado F.Mk 3. The aircraft flew with overwing tanks and also refuelled from BAe's pod-equipped Buccaneer to extend their endurance. When the radar trials ended, the fleet was grounded, the final end of the Lightning as an active aircraft.

Above: BAe's long-suffering hybrid F.Mk 3/6 escaped the paint-shop throughout its career, although it was adorned with various squadron markings to help units celebrate milestone anniversaries, in this case No. 56 Squadron.

Above: In late December 1992 the three airworthy survivors of the BAe fleet flew a farewell tour of former Lightning haunts.

Left: In addition to radar target work, XP693 was used as a chase aircraft for the Tornado programme and, seen here, with the EAP.

together for one more formation flight. On 16 December 1992, Peter Orme, Keith Hartley and Derek Reeh flew XP693, XR773 and XS904 (as 'Tarnish 3', '7' and '5') individually to Valley, Brough and Leeming, before rejoining to overfly Warton, Samlesbury and Blackpool airport. On 23 December 1992, XP693 and XR773 were delivered to the Lightning Flying Club at Exeter, joining the same organisation's T.Mk 5 XS451, held at Plymouth. They were respectively registered as G-FSIX and G-OPIB ('Go P.1B'). Having accumulated a huge stock of Lightning spares, and enjoying the support of a number of useful friends (including several BAe test pilots and former RAF Lightning pilots and engineers), the Lightning Flying Club is the type's best chance of getting back into the air, although the British CAA remains resolutely opposed to granting permission. XS928 was retained at BAe Warton for static display, while XS904 (the last Lightning to fly in military markings) was delivered to Bruntingthorpe on 21 January 1993 for display, where it remains virtually airworthy, and where it regularly taxis, alongside another ex-No. 11 Squadron F.Mk 6.

The Lightning Flying Club made a relatively modest start, when Plymouth Executive Aviation purchased T.Mk 5 XS451 for restoration to fly as G-LTNG. The organisation has grown as support has emerged. Its professional approach has impressed many, and there seems little doubt that with some co-operation from the CAA, one of their Lightnings could fly again. At the time when the RAF disposed of its last Lightnings, the Plymouth-based operation seemed to offer less chance of success than the Australian entrepreneur Arnold Glass, who already owned and flew a Folland Gnat, and whose declared aim was to own and fly a Mach 2 fighter. He bought six Lightnings (three F.Mk 6s and three T.Mk 5s), which alone seemed to establish his credentials, and was given a great deal of help

XP693 was the first aircraft from the F.Mk 3 contract and first flew on 16 June 1962. It was later converted to Interim F.Mk 6 standard, but was retained at Warton as a trials aircraft, later providing chase duties for the Tornado GR.Mk 1, F.Mk 2, F.Mk 3 and EAP programmes. It was joined on the radar test fleet by four ex-Binbrook aircraft: XR724, XR773, XS904 and XS928.

In January 1986 18 F.Mk 53s and four T.Mk 55s (illustrated) were flown back to Warton from Saudi Arabia, having been bought back as part of the Al Yamamah Tornado deal. Buyers such as Austria were sought for the aircraft but in the end they were put up for preservation.

Thankfully, many Lightnings have been preserved in museums or as gate-guards (Akrotiri above). Among the survivors is the SB.5, both P.1As (prototype right), one P.1B, two DB aircraft and five F.Mk 1s.

The last MPCs were memorable affairs as the Lightning pilots eagerly used up the last of the missile stocks. Here a No. 11 Sqn F.Mk 6 launches one of the last Red Tops over the Aberporth range. The targets were usually flares towed by Jindivik drones.

and co-operation by the RAF and No. 11 Squadron. He ended up with the best of the surviving Lightnings, all of which were flown into Cranfield during June 1988. The last pair (XS898 and XS923) left Binbrook on 30 June 1988, flown by Squadron Leaders John Aldington and Paul Cooper. Glass intended to restore one of the T.Mk 5s to flying condition for training, and then to fly one of the F.Mk 6s, using the other aircraft for spares and as back-ups. Accordingly, XS452 was allocated the civilian registration G-BPFE.

Unfortunately, Glass was unable to complete the ambitious project, and his six Lightnings (hand-picked as the very best of the Binbrook survivors) slowly deteriorated in open storage at Cranfield until finally, inevitably, they were auctioned by Sotheby's during a sale at Billingshurst on 27 November 1993. Four of them (XS898, sold for £2,500; XS899, sold for £2,200; XS923, sold for £2,200; and XV328, sold for £3,200) met their fate at the hands of a scrapman's cutting torch. The F.Mk 6 and T.Mk 5 noses survived and were shipped to Bruntingthorpe, while the two T.Mk 5s – XS452 and XS458 – were sold for £5,800 and £6,000 respectively, for restoration to fly. It was thought that '452 would join the fleet of Lightnings at Bruntingthorpe, and that '458 would go to a collector in Cyprus. In fact, both aircraft remained at Cranfield, in the hands of Tony Hulls and T.5 Projects.

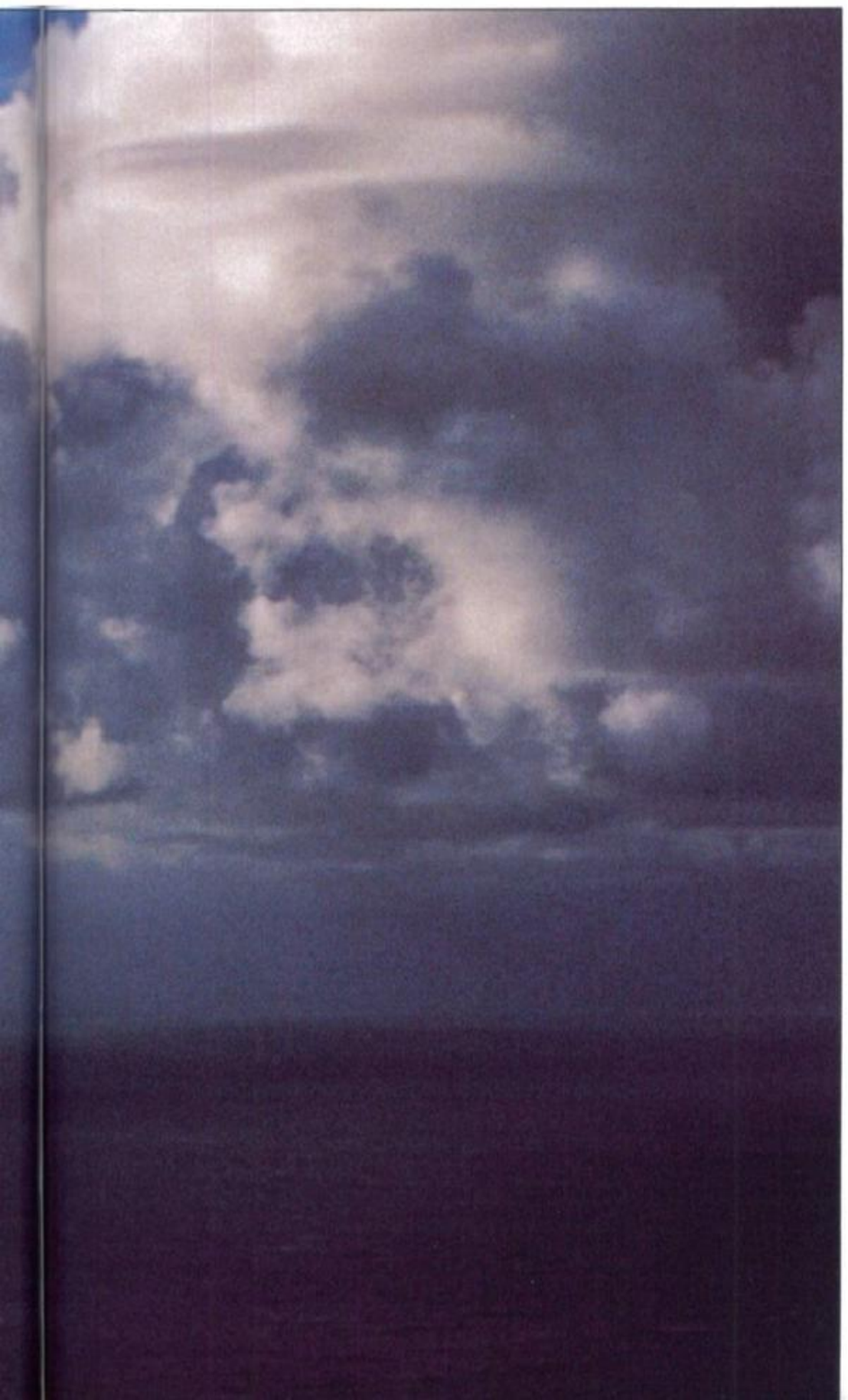
A lost chance?

In hindsight, many bemoaned the fact that these (potentially, the most likely Lightnings to fly again) aircraft had not originally gone to an unspecified someone who might have carried through their restoration to a more satisfactory conclusion, and doubt was cast on Glass's intentions when the aircraft were placed for sale soon after their arrival at Cranfield. Some suggested that they had been purchased as a speculative investment by the collector, although it does seem likely that he had intended to operate at least two of the aircraft himself. At the time, Glass seemed to offer the best chance of seeing an airworthy Lightning warbird.

There are other potentially airworthy Lightnings. Wensley Haydon-Baillie owns the RAF Museum's former P.1B, XA847 (given an airing at the 1994 Farnborough SBAC show), and the A&AEE's T.Mk 5 XS422. They are held in store in Southampton. The same man owns no fewer than 11 F.Mk 53s and four T.Mk 55s, dismantled and stored in the Warrington area. They are the bulk of the 22 ex-Saudi Lightnings 'bought back' by BAe and returned to the UK in 1986; most of the rest of these aircraft also survived the scrapman to go to museums and preservation groups.

South African collector

One of the surviving Cranfield Lightnings (T.Mk 5 XS452) was sold to the South African collector, Mike Beachy-Head, for restoration to fly as ZU-BBD. Beachy-Head had previously procured a number of Hawker Hunters, a Buccaneer and a Canberra, and these aircraft had all been restored to airworthy condition in the UK, then tested and ferried to South Africa under their South African registrations, approved by the South African CAA and authorised by the UK CAA in the same way as any foreign civil aircraft operating in UK airspace. When it came to the Lightning and a second Buccaneer acquired by the same collector, however, and after inspection and approval by the South African airworthiness authorities, the UK CAA reportedly refused to allow them to fly. Some suggested that this was all part of a plot designed not to give the UK Lightning restorations any precedent in order to press the case for their own airworthiness certificates or permits to fly. Undaunted, Beachy-Head purchased a second Lightning (F.Mk 6 XR773, G-OPIB, from the Lightning Flying Club) and arranged for both to be transported to Tilbury as underslung helicopter loads for onward shipment to South Africa.



The Lightning is a highly complex flying machine, demanding very high-maintenance input for every flying hour, and having a dangerous AVPIN starter, very high-pressure hydraulics, and servo-assisted controls. It is a very different proposition to a Venom, Canberra or Hunter (all of which have been able to gain CAA approval as civilian-operated 'warbirds'), and it seems unlikely that the Lightning Flying Club (or anyone else) will be given the necessary permissions which would enable them to put their aircraft back into the air.

A relatively large number of Lightnings have survived as gate guards and museum pieces, and two are even maintained in taxiing condition at Bruntingthorpe, where the Lightning Preservation Group hopes to reassemble the old QRA shed from RAF Wattisham. If the group succeeds, we might one day re-experience the drama of a Cold War-style scramble, culminating in a high-speed taxi along Bruntingthorpe's vast runway, but it seems unlikely that we will ever again experience the magnificent sight of a Lightning performing its famous rotation take-off, spearing skyward with burners blazing. For many, the Lightning marked the epitome of John Gillespee Magee's epic poem 'High Flight', and there are still those for whom the memory of flying the Lightning evokes the thought of "dancing the skies on laughter-silvered wings." **Jon Lake**

XS904 has the privilege of being the last Lightning to fly, delivered to Bruntingthorpe on 21 January 1993. Here it is owned by the Lightning Preservation Group, whose tireless volunteers maintain it in theoretically airworthy condition, although its operations are restricted to high-speed 'thunder runs' along the runway. Many other late Lightnings are also kept in airworthy condition, although CAA restrictions prevent them from flying.

In Saudi Arabia and Kuwait several Lightnings remain on display. One of the notable aircraft is this T.Mk 54 on a pole at Dhahran.

Below: This Saudi display aircraft at Dhahran is one of the F.Mk 52s. Another Saudi survivor is a DB aircraft supplied for ground instruction.

Below: Following abortive attempts to sell their aircraft, the Kuwaitis put most of the survivors on display. Some were damaged by Iraqi troops during the 1990 occupation.

Lightning Operators

Royal Air Force

Most of the 339 Lightnings built were delivered to the RAF. Two P.1As were followed by three P.1Bs and a development batch of 20 pre-production P.1Bs, later known as Lightning F.Mk 1s. None of these aircraft ever reached front-line service, but several were used by the A&AEE and three served with the AFDS. There were 19 full production F.Mk 1s and 28 F.Mk 1As. They were followed by 44 F.Mk 2s and 70 F.Mk 3s. Sixteen aircraft were built as F.Mk 3As (Interim F.Mk 6s) and 39 more were built as F.Mk 6s from scratch. Thirty-one F.Mk 2s were subsequently converted to F.Mk 2A standards, while five became export F.Mk 52s, one became an F.Mk 3 and another an F.Mk 3A. The F.Mk 3 prototype itself was produced by conversion of a Development Batch P.1B, while nine F.Mk 3s and all 16 F.Mk 3As became F.Mk 6s. Two-seat production included two T.Mk 4 prototypes, 20 T.Mk 4s and 22 T.Mk 5s. BAC built a further 46 export F.Mk 53s and eight T.Mk 55s, and their serials are detailed under the Saudi and Kuwaiti entries.

Seventy-four RAF Lightnings were written off in service. The force's strength peaked at about 150 aircraft during the late 1960s, declining to 82 aircraft at the end of 1974, 58 at the end of 1975 and 35 after the disbandment of the RAF Germany squadrons. That fleet remained fairly constant (supported by rotation to and from a large number of stored airframes) until 1987, when the final rundown began.

Prior to the 1966 Air Council ruling which standardised unit markings, the Lightning squadrons were noted for their gaudy colours, demonstrated here by a mixed group of F.Mk 2s and F.Mk 3s. Many of the early schemes were driven by the annual assignment of a Lightning squadron to provide the Fighter Command display team.

In RAF service, the Lightning took over the air defence of the UK from an assortment of day-fighter Hawker Hunters and all-weather Gloster Javelins. By 1964, the Lightning force consisted of six home-based front-line air defence squadrons, and this number remained broadly constant despite the movement of several of the original units to overseas bases. Two squadrons (Nos 19 and 92) transferred to RAF Germany in late 1965, replacing two squadrons of Javelins (Nos 5 and 11), but these units then returned to the UK and reformed with Lightnings in December 1965 and April 1967. The move of Nos 19 and 92 to Germany allowed Fighter Command to standardise on the AI.23B-equipped, Red Top-armed F.Mk 3 and F.Mk 6, with the earlier F.Mk 1s and F.Mk 1As retired to second-line duties. No. 56 Squadron moved to Cyprus in 1967, replacing the Javelin-equipped No. 29 Squadron, which returned to the UK and reformed with Lightnings. When No. 74 Squadron moved to the Far East Air Force in June 1967, no new Lightning squadron formed, but the UK's air defences were soon bolstered by a squadron of F-4 Phantoms.

RAF Fighter Command disbanded in 1968, but this made little difference to the UK-based Lightning units which reported instead to HQ No. 11 Group of the new Strike Command. The situation remained unchanged for some time, although No. 74 disbanded in 1971 upon the rundown of British forces East of Suez. The introduction of the Jaguar fighter-bomber marked the beginning of the rundown for the Lightning, since Coltishall, long the home of the Lightning OCU, became the first Jaguar base. Moreover, when the Jaguar replaced Phantoms in the strike/attack role, the F-4s became available to re-equip the Lightning air defence squadrons. With the writing on the wall, the Lightning OCU disbanded at the end of September 1974. Of the RAF's front-line Lightning squadrons, No. 74 had already disbanded, No. 111 disappeared on the same day as the OCU, and No. 29 followed at the end of the year. No. 56 Squadron had only nine months of service left, and No. 23 Squadron lasted just over a year. In Germany, No. 19 disbanded on 31 December 1976, while No. 92 was destined to serve until 1 April 1977. All re-equipped with the Phantom. Only at Binbrook did the Lightning remain in long-term service, where Nos 5 and 11 Squadrons (and the LTF) served on until 1987 and 1988. At one time it seemed likely that Binbrook would get a third front-line squadron, and the two-letter code series commencing 'CA' was reserved for this unit, which unfortunately remained stillborn.

RAF Lightning production

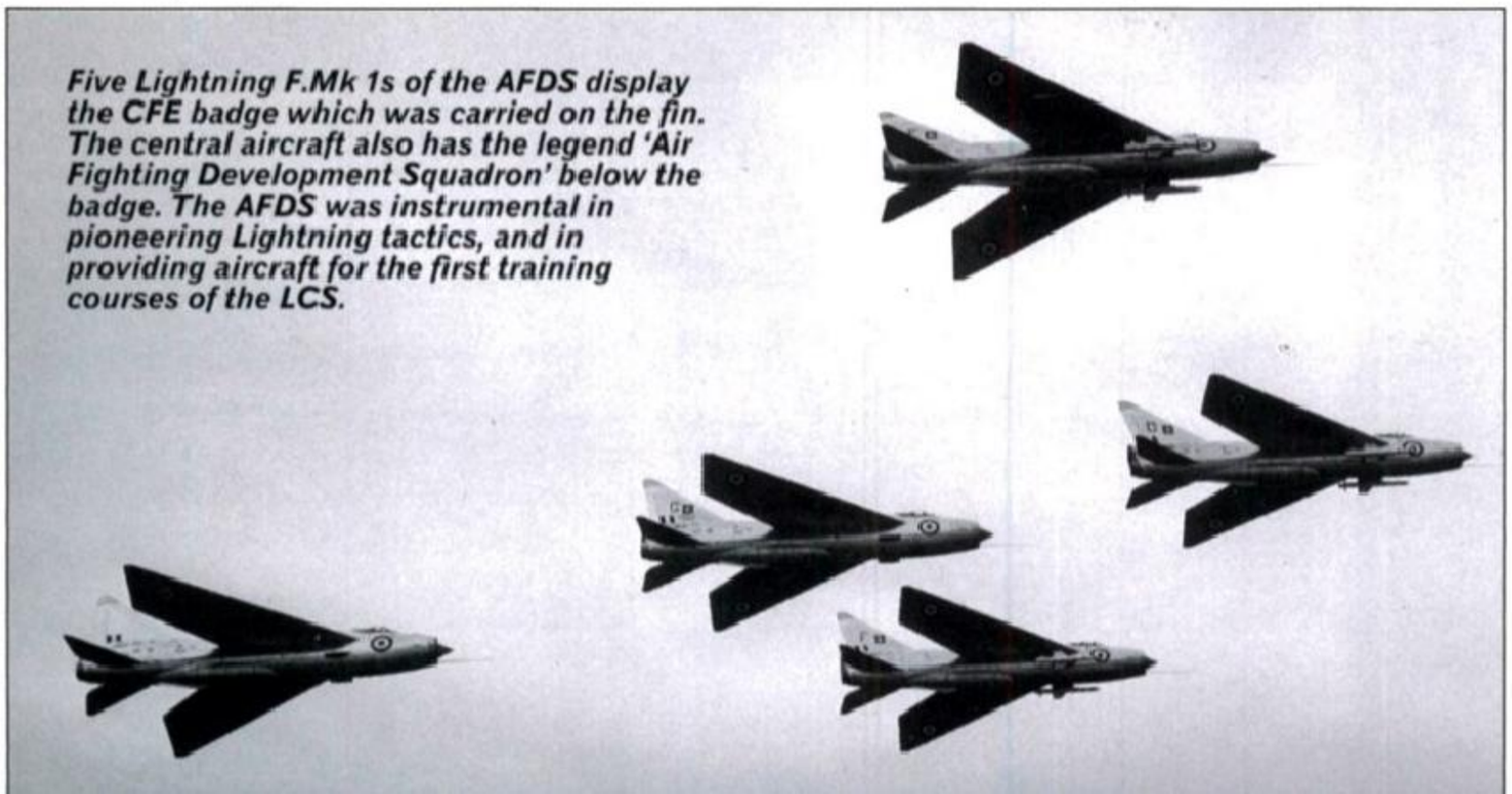
RAF serials	c/n	remarks
P.1A (2 prototypes, one static test)		
WG760, WG765, WG763	95001/95003	WG765/95002 static test airframe
P.1B (3 prototypes)		
XA847	95004	modified with long dorsal fin
XA853	95005	
XA856	95006	
P.1B/Lightning F.Mk 1 (20 pre-production aircraft)		
XG307/XG313	95007/95013	XG310 became F.Mk 3 prototype
XG325/XG337	95014/95026	
Lightning F.Mk 1 (19 production aircraft, one static test)		
XM134/XM147	95030/95043	
XM163/XM168	95044/95049	XM168/95049 static test airframe
Lightning F.Mk 1A (28 production aircraft)		
XM169/XM183	95056/95070	
XM184/XM192	95082/95090	
XM213/XM215	95091/95093	
XM216	95095	
Lightning F.Mk 2 (44 production aircraft)		
XN723	95096	
XN724	95094	converted to F.Mk 2A
XN725	95097	modified to F.Mk 3A before first flight
XN726/XN727	95098/95099	both converted to F.Mk 2A
XN728/XN733	95105/95110	XN728, XN730, XN731, XN732, XN733 converted to F.Mk 2A. XN729 converted to F.Mk 52
XN734	95113	modified to F.Mk 3 before first flight, later to F.Mk 3A
XN735	95114	converted to F.Mk 2A
XN767	95115	converted to F.Mk 52
XN768/XN797	95121/95150	XN771/XN778, XN780/XN784, XN786/XN793 and XN795 converted to F.Mk 2A. XN770, XN796 and XN797 converted to F.Mk 52
Lightning F.Mk 3 (70 production aircraft)		
XP693	95116	converted to F.Mk 3A
XP694	95117	
XP695/XP696	95119/95120	
XP697/XP708	95151/95162	XP697 converted to F.Mk 3A
XP735/XP765	95163/95193	
XR711/XR722	95194/95205	XR722 became prototype F.Mk 53
XR723/728, XR747	95206/95212	all first flew as F.Mk 3, then converted to F.Mk 6
XR748/XR751	95213/95216	XR749 partially converted to F.Mk 6, then reverted to F.Mk 3
Lightning F.Mk 3A (16 Interim F.Mk 6 production aircraft)		
XR752/XR767	95217/95232	all upgraded to full F.Mk 6 apart from XR766
Lightning T.Mk 4 (two prototypes and 20 production aircraft)		
XL628/XL629	95049/95050	prototype aircraft
XM966/XM970	95051/95055	XM966 and XM967 converted to T.Mk 5
XM971/XM974	95071/95074	
XM987/XM992	95075/95080	XM989 and XM992 converted to T.Mk 54
XM993/XM994	95100/95101	
XM995	95104	
XM996	95103	
XM997	95111	
Lightning T.Mk 5 (22 production aircraft)		
XS416/XS423	B1-95001/B1-95008	
XS449/XS460	B1-95009/B1-95020	XS460 converted as first T.Mk 55
XV328/XV329	B1-95021/B1-95022	
Lightning F.Mk 6 (39 production aircraft)		
XR768/XR773	95233/95238	
XS893/XS904	95239/95250	
XS918/XS938	95251/95271	

Central Fighter Establishment

Air Fighting Development Squadron/Lightning Conversion Squadron

The Air Fighting Development Squadron of the CFE received the RAF's first Lightnings in December 1959, when three pre-production aircraft were delivered to Coltishall. They were used for evaluation and tactical development work, and were also borrowed by the Lightning Conversion Squadron, which formed as a constituent part of the CFE on 4 January 1960, but which moved to Middleton St George in August 1961. Successive Lightning variants were used by the AFDS for pre-service tactical development, with one mark generally giving way to the next. Lightning F.Mk 1s arrived on 25 May 1960, T.Mk 4s in August 1962, F.Mk 2s in November 1962, F.Mk 3s in January 1964, and F.Mk 6s in November 1966. The unit moved to Binbrook in October 1962, where it eventually became the Fighter Command Trials Unit on 1 February 1966.

At Middleton St George the Lightning Conversion Squadron continued to borrow aircraft (though now mainly from No. 74 Squadron at Coltishall, and from Nos 56 and 111 Squadron at Wattisham) before finally gaining its own aircraft from 27 June 1962. The unit received eight T.Mk 4s (losing one) before it redesignated as No. 226 OCU on 1 June 1963.



Five Lightning F.Mk 1s of the AFDS display the CFE badge which was carried on the fin. The central aircraft also has the legend 'Air Fighting Development Squadron' below the badge. The AFDS was instrumental in pioneering Lightning tactics, and in providing aircraft for the first training courses of the LCS.

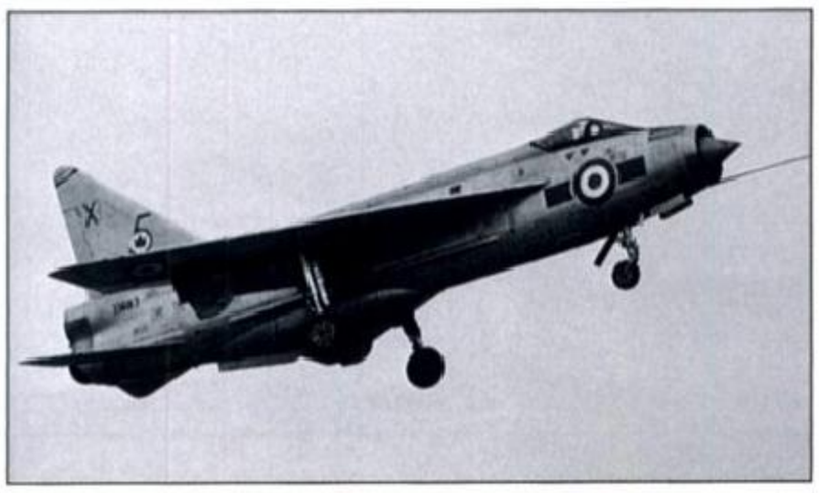
Below: In addition to the fin badge, AFDS aircraft like this F.Mk 1 (XM137) sometimes also wore red (top) and black nose bars.

Left: No. 5 Squadron operated the F.Mk 3 in the target facilities role, this example retaining its natural metal finish in 1976. Two F.Mk 3s were kept on squadron strength until 1987, the lighter version being more manoeuvrable, better performing and generally more suitable for aerobatic displays.

No. 5 Squadron

No. 5 Squadron reformed at Binbrook on 8 October 1965, having hitherto been a Javelin-equipped unit in RAF Germany. The unit added Lightning T.Mk 5s to a single Hunter T.Mk 7 from 19 November, and Interim F.Mk 6s from 10 December. No. 5 won the Dacre Trophy (awarded to the top UK-based fighter squadron) in 1968 and 1969, then took NATO's Huddleston Trophy (for the best NATO interceptor squadron) in May 1970. Between early 1971 and September 1972, No. 5 operated a flight of F.Mk 1s in the target facilities role, these aircraft then forming the Binbrook TFF. In October the F.Mk 1As were replaced by F.Mk 3s. No. 5 Squadron retained F.Mk 3s longer than its neighbour, keeping the lighter aircraft specifically for display use during the 1987 air show season. The aircraft (XP741 and XR716) were respectively flown to Manston and Cottesmore on 30 September 1987, marking the end of the F.Mk 3's service career. On 7 November 1987 No. 5 Squadron flew a final nine-aircraft farewell flypast, disbanding on 31 December.

No. 5 Squadron's first Lightnings carried simple red bars flanking the nose roundel, with a green maple leaf on a white disc on the tailfin. From 1970, a large red '5' was added to the fin, its 'tail' encircling the maple leaf badge. This marking was revived in 1986 to celebrate the unit's 70th anniversary and 21 years on Lightnings.



Left: With the end of the Binbrook Target Facilities Flight, the elderly F.Mk 1As were reassigned to No. 5 Squadron.

Below: In the late 1970s one No. 5 aircraft was painted with these trial squadron markings, consisting of a green maple leaf on a red band.

Nose markings were reduced in size in 1975, and from 1981 most aircraft had them removed altogether, replaced by a small maple leaf on the fin, flanked by tiny red bars. Special markings included sharkmouths added to three aircraft during an APC at Akrotiri in 1984, and a red spine, fin and leading edges applied to the CO's aircraft in late 1986.

Above: In addition to the standard '5' tail markings, many of the unit's Lightnings received Maltese crosses during APCs at Luqa.

Below: Muted squadron markings accompanied the change to air defence grey camouflage.

No. 11 Squadron

No. 11 disbanded as a Javelin squadron when replaced in RAFG by one of the F.Mk 2 squadrons hitherto stationed at Leconfield. Although No. 5 re-equipped with Lightnings at Binbrook (which effectively replaced Leconfield), No. 11 remained inactive for over a year and then went to Leuchars where it replaced No. 74, which had moved out to Singapore. On 1 April 1967 No. 11 Squadron with its brand new F.Mk 6s joined No. 23 Squadron at RAF Leuchars. No. 43 Squadron formed with Phantoms in April 1969, and, once these had worked up, No. 11 moved south to join No. 5 at Binbrook on 22 March 1972. No. 11 Squadron formed a conversion and training flight in October 1975, eventually becoming the LTF. Soon after its arrival at Binbrook, No. 11 Squadron picked up a handful of F.Mk 3s for aerobatics and target facilities. It finally retired them in May 1986. The squadron's F.Mk 6s and T.Mk 5s went on until 30 June 1988, although the unit officially down-declared on 30 April 1988, five days after a new No. 11 Squadron formed at Coningsby with Tornado F.Mk 3s.

When No. 11 moved from Leuchars to Binbrook, it applied much larger eagles to the aircraft fins.

By the time No. 11 Squadron re-equipped with the Lightning, squadron markings were scrupulously standardised in size and presentation. Thus the squadron's first F.Mk 6s had the unit's two-eagle badge in a small white disc on the fin (this later being rimmed in black), with the traditional black rectangle and superimposed yellow diamond broken by the roundel. The small buff-coloured eagles worn at Leuchars were replaced soon after the squadron moved to Binbrook, with two much larger black

This camouflaged F.Mk 6 carries overwing tanks from an air defence grey aircraft. In the mid-1970s No. 11 also undertook Lightning conversion.

No. 11 had the distinction of being the final operational Lightning user.

eagles, outlined in white. Some aircraft received small toned-down markings when the fleet was toned down in 1981, with the black eagles presented in a tiny yellow disc near the fin-tip, this being flanked by miniature versions of the nose bars (which were removed). The CO's aircraft received a black fin and spine in late 1986, as did its replacement.

The final nine-ship formation ever flown by the Lightning was mounted by No. 11 Sqn (with one LTF F.Mk 6) in 1988. The formation illustrates the considerable differences in colour scheme across the fleet. Note the black-tailed flagship in the lead.

No. 19 Squadron

No. 19 Squadron at Leconfield began conversion to the Lightning on 29 October 1962, when the first T.Mk 4 arrived. The last Hunters did not depart until February 1963, two months after the single-seat F.Mk 2s began to arrive. The squadron was declared fully operational in the summer of 1963 and in early 1964 flew a demonstration for the Saudis, staging from APC in Cyprus via Bahrain. In early 1965, the squadron began operating with its aircraft in four-gun configuration, undertaking ground attack training in preparation for its anticipated secondary role in RAF Germany. No. 19 moved to Gütersloh on 23 September 1965, and began to convert to F.Mk 2As in 1966, completing the process in July 1970, when the unit had 13 F.Mk 2As on charge, with one F.Mk 2 for target facilities and one T.Mk 4. The squadron finally disbanded on 31 December 1976.

No. 19 Squadron's Lightnings were never as colourfully marked as those belonging to their great rivals, No. 92, since coloured fins and spines were never adopted. The squadron's famous dolphin badge remained constant on the fin, and the blue and white nose checkers altered little, changing from 10 ahead of the roundel and six aft to six on each side. Checkers were reduced in size when camouflage was introduced.

No. 19 initially operated the F.Mk 2 (below), before adopting the F.Mk 2A (right) from 1966.

No. 23 Squadron

No. 23 Squadron at Leuchars traded in Javelins for Lightnings, receiving the first pair of F.Mk 3s on 18 August 1964. The grounding of the Valiant tankers had a catastrophic effect on the Leuchars wing, whose Lightnings needed tanker support in order to successfully intercept marauding Soviet reconnaissance aircraft. USAF KC-135s were used to make up the shortfall until Victor tankers could take over. No. 23 Squadron was awarded the Dacre Trophy in May 1967, and provided the Fighter Command Display aircraft (and pilot) that same year. Until 1965, a Lightning squadron had provided an aerobatic display team, but this had proved to impose unacceptable constraints on operational readiness. With the newly-formed No. 11 Squadron operating F.Mk 6s at Leuchars, it was decided that the wing would standardise on the new long-range version. Thus No. 23 Squadron itself began conversion to the F.Mk 6 during May 1967, its discarded F.Mk 3s going to the reforming No. 29 Squadron. No. 23 Squadron disbanded on 31 October 1975.

No. 23 reformed when squadron markings were at their most colourful. Accordingly, the unit's aircraft were actually delivered with white spines and tailfins, the latter decorated with a large red and black eagle and with the fin flash at the leading edge. Following the imposition of more restrained markings after the Air Council in 1966, the same badge was carried in the standard 18-in (45-cm) disc, and the white fin and spine were removed. The nose markings, of blue/red/blue rectangles flanking the roundel, remained unchanged. In 1970, the squadron reapplied its eagle badge much larger, and in 1975 the squadron commander's aircraft (XR753 'A') regained a white fin for its last months in service.

No. 23 operated the F.Mk 3 (below) until 1967, when the F.Mk 6 (right) was adopted. One of the latter has the larger eagle fin badge which began to appear in 1970.

No. 29 Squadron

No. 29 Squadron reformed at Wattisham on 1 May 1967, initially equipped with four F.Mk 3s left behind by No. 56 Squadron, which had moved out to Cyprus to replace the old Javelin-equipped No. 29 Squadron. The unit was soon brought up to full strength with F.Mk 3s discarded by Nos 23 and 74 Squadrons and was operational by September 1967. The unit was destined to be relatively short-lived as a Lightning squadron, lasting less than eight years before it disbanded on 31 December 1974.

Because No. 29 Squadron did not convert to the Lightning until after the famous 1966 Air Council ruling, its markings were never particularly spectacular. An adaptation of the squadron's red eagle attacking yellow buzzard badge was carried on the fin in an 18-in white disc, and red-outlined bars flanking the roundel carried the squadron's XXX marking. The nose bars were extended in length in 1968, and the fin badge gained a red ring around the disc.

No. 29 was the shortest-lived of the Lightning operators, being equipped with the F.Mk 3 as its operational equipment. This example (right) is seen during an APC at Luqa. A single T.Mk 5 (left) was assigned for training purposes.

No. 56 Squadron

No. 56 Squadron became the RAF's second Lightning squadron when it received its first F.Mk 1A at Wattisham on 14 December 1960. The squadron moved temporarily to Coltishall while it worked up, while Wattisham's runways were repaired. In 1963, No. 56 Squadron took over from No. 74 as the Fighter Command aerobatic team, its aircraft operating as the 'Firebirds'. The aircraft had their radar sets removed and replaced by ballast, but the team flew only a handful of displays, losing one aircraft during rehearsals. The squadron converted to the F.Mk 3 in 1965. No. 56 Squadron moved to Akrotiri, Cyprus, from 11 April 1967, soon gaining a Canberra target facilities flight. When No. 74 Squadron in Singapore disbanded, its F.Mk 6s were flown back to Cyprus, where they re-equipped No. 56 Squadron from August 1971. The squadron flew intensive combat air patrols during the Turkish invasion of northern Cyprus, then moved back to the UK to Wattisham (vacant since late 1974, on the disbandment of its two F.Mk 3 units, Nos 29 and 111 Squadrons) in January 1975. No. 56 won the Dacre Trophy in 1975, its diamond jubilee year, before disbanding on 28 June.

No. 56 Squadron's first Lightnings wore relatively restrained markings, with large red and white nose checkers thinly outlined in pale blue (eight full checks ahead, two aft) flanking the roundel, and with a small phoenix badge. The latter was soon enlarged (from 1962), and from 1963 the aircraft received red fins and spines, with the phoenix badge in a large white disc. If this was not gaudy enough, the fin flash was enlarged, raked and moved to the leading edge, while wing and tailplane leading edges were painted red. When the squadron re-equipped with F.Mk 3s, even more colourful markings were devised. The phoenix badge was actually very small, but was applied to an enormous red and white arrowhead in front of the roundel. The spine remained red, and code letters were applied in red (outlined in white) to the airbrakes. The entire fin was covered in red and white checkers. Lightning squadron markings had become steadily more colourful and the new No. 56 Squadron scheme was the final straw, prompting an Air Council ruling to the effect that markings would henceforth be toned down and reduced in size. Smaller red and white checkers flanked the roundel (six per side) while the Phoenix badge was applied in a tiny 18-in fin disc. In Akrotiri, however, the squadron was 'out of sight and out of mind' and the Phoenix insignia was reapplied much larger on the fins of the last F.Mk 3s and the F.Mk 6s.

When the 'Firebirds' first moved to Cyprus, they flew the F.Mk 3 (above). After four years with the straight-wing Lightning they converted to the ultimate model, the F.Mk 6 (below). The squadron had a brief return to Wattisham in 1975 before disbanding as a Lightning user.

Above: During the 1963 display season, the 'Firebird' F.Mk 1As wore very colourful markings, including flame-red fins, spines and wing leading edges.

Left: No. 56 Sqn utilised the extra fin area of the F.Mk 3 to great effect with its new markings, introduced with the new variant in 1965.

No. 74 Squadron

Its performance in the Battle of Britain had made No. 74 arguably the RAF's foremost fighter unit, and it was a natural choice to become the first Lightning squadron. The unit moved to Coltishall with its Hunters in June 1959, in preparation for conversion to the new fighter. Lightning F.Mk 1 XM165 was allocated to No. 74 on 29 June 1960, but was delivered to the AFDS, temporarily detached to Leconfield while Coltishall's runway was undergoing repairs. The squadron finally received the aircraft on 11 July. Within 11 days all of the squadron's pilots had flown at least one Lightning sortie, and conversion was rapid. Since two-seat Lightnings were not to arrive for another three years, the first flight was a great step for pilots used to the Hunter, even with an instructor flying chase in the squadron's Hunter T.Mk 7. "Superb – I was with it all the way until I let the brakes off!" one pilot commented after his first solo. The squadron had 12 Lightning F.Mk 1s on charge by 26 September, and all 16 squadron pilots were deemed 'operational' by January 1961. The squadron flew as a nine-aircraft aerobatic team at the 1961 Paris Air Salon, and borrowed four aircraft from the AFDS to allow it to fly further displays at Farnborough and a number of

This pair of No. 74 Sqn F.Mk 1s displays the early muted markings. Note the open cannon ports.

Along with No. 56, the 'Tigers' were the only unit to operationally fly all three generations of Lightning. Here is an F.Mk 3.

Left: During the heyday of the colourful markings, No. 74 adopted black fins and spines, with the fin-flash moved to the leading edge.

Right: 'Tigers' F.Mk 6s execute a classic fighter break. No. 74 began its transition to the F.Mk 6 in the summer of 1966, in preparation for taking its aircraft to Singapore. Once away from the strict eyes of the Air Council, the black fins returned to the squadron's aircraft.

Battle of Britain displays at RAF stations. No. 74 moved to Leuchars on 28 January 1964, converting to F.Mk 3s from 14 April.

The squadron had visited Denmark, Sweden and Norway during 1962, with its F.Mk 1s, which were not equipped for inflight refuelling. With the probe-equipped F.Mk 3s the squadron was able to deploy to Cyprus in August 1965, flying on to pay a courtesy visit to Iran. Having been the first Lightning unit, and then the first with the F.Mk 3, No. 74 went on to become the first unit with the definitive heavyweight F.Mk 6, receiving its first aircraft on 1 August 1966. The squadron moved out to Tengah, Singapore, on 4 June 1967. No. 74 disbanded on 25 August 1971, flying its F.Mk 6s to Cyprus, where they replaced No. 56 Squadron's F.Mk 3s. Remarkably, this historic squadron remained in limbo until 1984.

No. 74 Squadron's Lightnings initially wore the unit's tiger's head badge on a white disc on the fin, with tiger stripe triangles in rectangles fore and aft of the roundel. From late August 1962, fins and spines were painted black, and the code letters were reapplied in yellow. With the arrival of the F.Mk 3, the fin flash was relocated to the leading edge and outlined in yellow, while the nose insignia was increased in size, with eight triangular 'segments' in front of the roundel and four behind. Yellow tiger-stripe markings were even applied to refuelling probes on some aircraft, but all this came to an end in 1966, when the black areas were removed, the nose markings were reduced in size, and the tiger's head was placed in an 18-in disc. Once out in Singapore, the black fins reappeared, and it has been suggested that this flagrant disregard of Air Council intentions led to the unit's subsequent long years in the 'wilderness'.

No. 92 Squadron

No. 92 Squadrons pilots underwent Lightning conversion at Middleton St George in early 1963, returning to Leconfield and their Hunter F.Mk 6s while waiting for their first Lightnings to arrive in March and April. The squadron reached full establishment in June, and was declared operational. Thereafter, No. 92 Squadron's history shadowed that of No. 19, although the unit gained the distinction of replacing No. 56 as the Fighter Command aerobatic team. No. 92 moved to RAF Geilenkirchen on 29 December 1965, but the squadron then moved again to join No. 19 at Gütersloh in February 1968. Like No. 19, the squadron converted to F.Mk 2As, and finally disbanded on 1 April 1977.

Below: After operating F.Mk 2s at Leconfield, No. 92 moved to Germany, based initially at Geilenkirchen.

No. 92 Squadron's first aircraft had red and yellow chevrons flanking the nose roundel, these forming an arrowhead shape. The squadron's cobra and maple leaves badge was applied in a large white disc on the fin. Even while deliveries were taking place, the squadron adopted dark blue tailfins, and the fin flash was moved forward, raked and outlined in white. In 1964, the blue fin colour was extended forward to cover the spine. Safely ensconced in RAF Germany, No. 92 Squadron escaped the 1966 edict toning down Fighter Command squadron markings. The chevron arrowhead flanking the roundel was replaced by red and yellow checkers in 1968, but blue fins and spines remained until 1971. Even when the blue areas were removed, squadron insignia remained larger than was permissible in Fighter Command, though the nose checkers were much reduced in size when the aircraft received their matt dark green upper surfaces from 1972. The fin code then changed to yellow (from black) for higher conspicuity. In the final year of operations two blue diamonds were applied below the fin badge, and the CO's aircraft gained a small crown above the cobra's head, with the words 'King Cobra' beside it.

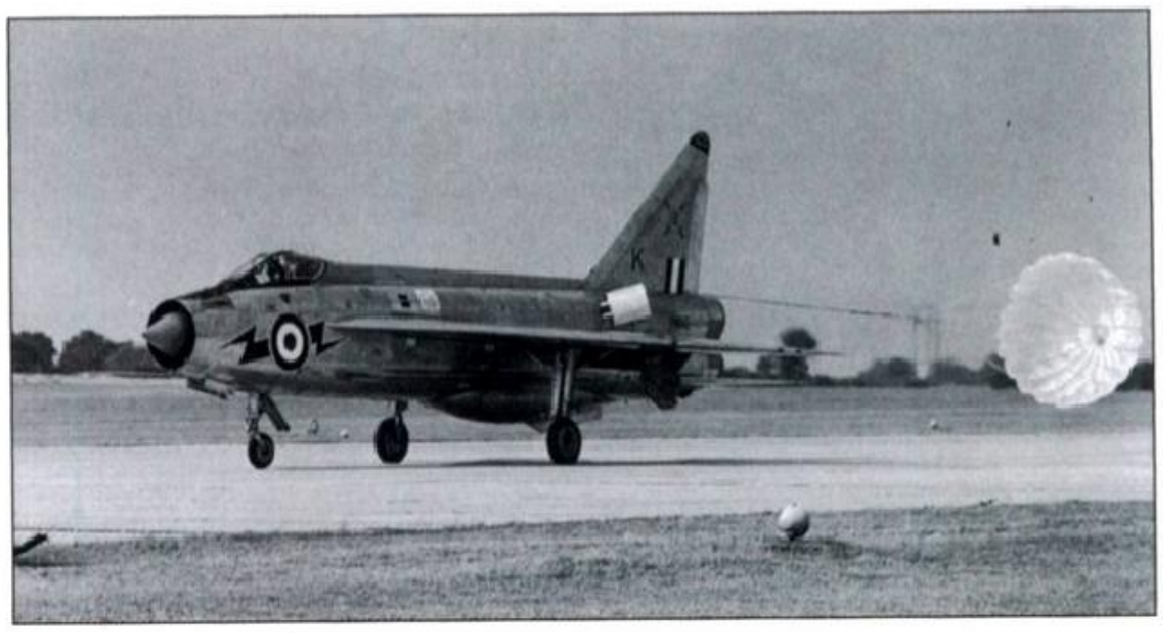
Right: A pair of F.Mk 2As is caught during the transition to camouflage. The nearest aircraft is 'King Cobra', named 'Flagship 92' for the CO.

No. 111 Squadron

'Treble One' was the RAF's third Lightning squadron, receiving its first F.Mk 1A at Wattisham on 6 March 1961. Early operations included refuelling from FAA Sea Vixens and a deployment to Gütersloh in Germany. By late 1964 the squadron had to use borrowed F.Mk 2s and F.Mk 1s, following high attrition, but from 7 November the squadron began to re-equip with its own F.Mk 3s. With these, the squadron formed the Fighter Command aerobatic team, displaying them first for

The F.Mk 3s of No. 111 Sqn line the ramp at Luqa during an Armament Practice Camp. In the foreground is the unit's T.Mk 5 trainer.

Above: Both F.Mk 1As and F.Mk 3s (illustrated) appeared in 'Treble One's' black and yellow marks.



Right: No. 111 was the third Lightning squadron, joining No. 56 at Wattisham with F.Mk 1As.

Churchill's funeral flypast. Before it disbanded, on 15 May 1974, No. 111 Squadron gained three F.Mk 6s from No. 23 Squadron, and they were used to give experience of the heavyweight variant to those of the squadron's pilots destined to move to F.Mk 6 squadrons. This meant that No. 111 had operated examples of every Lightning version, except the F.Mk 2A, a unique achievement. The F.Mk 6s used by 'Treble One' were not fitted with guns, like the Wattisham F.Mk 3s. No. 111 Squadron disbanded on 30 September 1974, and many of its aircraft were scrapped at the Suffolk airfield in May 1975.

No. 111's earliest Lightnings had simple markings, with a black lightning bolt, outlined in yellow, flanking the roundel, and with the squadron's Jerusalem Cross (with superimposed Seaxes) in yellow (and in turn superimposed on two red crossed swords) on the fin. More colourful markings appeared in early 1964, when aircraft gained a black fin and spine, with a yellow flash aft of the cockpit, and a sloping yellow panel in the fin, parallel to the leading edge. The squadron badge was applied in the centre of this panel, in a large black disc. When squadrons were directed to 'tone down', No. 111 complied, applying its badge in an 18-in (45-cm) white disc on the fin. Shortly before disbandment, in early 1974, the squadron badge was enlarged and applied in a black disc, while the fin flash was moved right to the leading edge and increased in height.

No. 226 Operational Conversion Unit

When the OCU contracted to two constituent squadrons, No. 2T Squadron applied its own markings.

No. 226 OCU was formed by the retitling of what had been the CFE's Lightning Conversion Squadron, on 1 June 1963. It took over the LCS's seven Lightning T.Mk 4s, and received seven former No. 74 Squadron F.Mk 1s. The OCU took the shadow identity of No. 145 Squadron (for use in time of war) in August 1963, and moved from the newly rebuilt Middleton St George to Coltishall on 13 April 1964. Middleton was sold for a nominal sum (£340,000), becoming Teesside Airport. The Lightning F.Mk 1 had only a brief career with No. 226 OCU, being replaced by ex-Nos 56 and 111 Squadron F.Mk 1As from February 1965, the last F.Mk 1 leaving on 17 June 1965. The T.Mk 5 was introduced on 20 April 1975, and from June 1973 the unit received Lightning F.Mk 3s, bringing the unit strength up to about 40 aircraft.

The original No. 145 Squadron colour scheme was extremely striking, with a predominantly red spine and a red chevron on the fin leading edge, with segments of white immediately behind the canopy and covering the rest of the fin. The squadron's badge of a cross and sword were applied to the red portion of the fin, in a large white shield. The aircraft's 'last three' were painted on the nose, ahead of the roundel. After the toning down of Lightning markings, the aircraft wore a simple version of No. 145's sword and cross badge in a disc on the fin, with white rectangles, each containing the cross of St George, flanking the roundel.

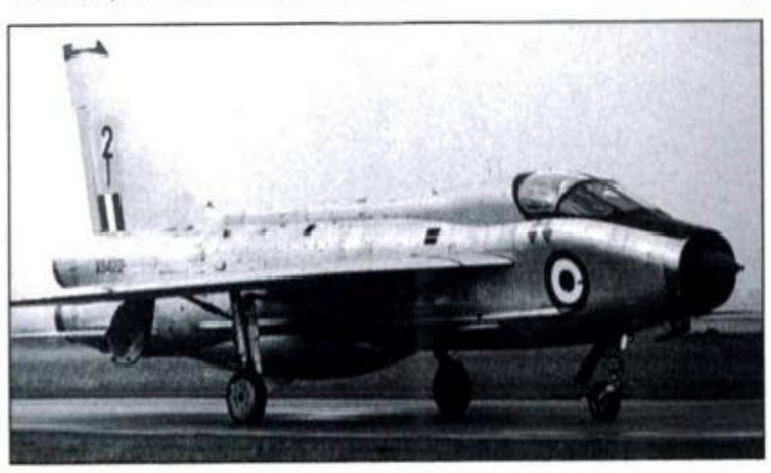
The OCU was divided into three squadrons: No. 1 was responsible for initial conversion (70 hours) using the T.Mk 4 and F.Mk 1A, No. 2 for radar conversion using the AI.23 radar, and No. 3 for advanced weapons training (including Red Top and AI.23B) using T.Mk 5s. No. 3 Squadron trained only those pilots destined for F.Mk 3s and F.Mk 6s; pilots for the F.Mk 2 in Germany remained with No. 2. The squadron also looked after Saudi conversion, using four T.Mk 55s attached to the unit for 18 months from February 1968.

The three squadrons were reduced to two during 1970. The whole OCU continued the No. 145 Squadron shadow identity, until June 1971 when No. 1 Squadron (which operated the F.Mk 1s and T.Mk 4s) took the shadow identity of No. 65 Squadron, leaving No. 2T Squadron (with the F.Mk 3s and T.Mk 5s) without a 'wartime' reserve identity. The reason for the F.Mk 1As to gain a war role and shadow identity seems unfathomable – most had been stripped of radar like the TFF aircraft, whereas No. 2T Squadron's F.Mk 3s were operationally representative. With the introduction of the Jaguar it was clear that surplus F-4 Phantoms would soon be available to replace the Lightnings, and No. 226 OCU disbanded at the end of September 1974, passing over the (reduced) training commitment to No. 11 Sqn's new 'C' Flight.

When No. 226 OCU gained its new shadow identity, the No. 1 Squadron aircraft received a small representation of No. 65 Squadron's badge on their tailfins, with red chevrons on white bands flanking the roundels. No. 2 Squadron gained a fin badge consisting of a red Roman II superimposed on a dark blue 'olde English' T in a disc, with pale blue triangles, outlined in white, flanking the roundel. One aircraft had the fin and spine in white.

Above: Ex-front-line F.Mk 1As saw service with the OCU, this example wearing the standard No. 145 Sqn marks.

Above: Initially OCU aircraft wore this colourful 145 Sqn scheme. The T.Mk 4s also had the yellow 'T-band'.



Above: This T.Mk 5 has muted markings for No. 2T Squadron.

Right: 226 OCU's No. 1 Sqn adopted No. 65 Sqn shadow markings in 1971. This is one of the long-suffering F.Mk 1As.

Fighter Command Trials Unit

The Fighter Command Trials Unit came into existence on 1 February 1966, when the AFDS was redesignated. It began life operating four F.Mk 3s, but these had been replaced by Interim F.Mk 6s by July 1966. The first two target facilities Lightning F.Mk 1s (stripped and fitted with a Luneberg lens radar reflector) were assigned to the FCTU at Binbrook in February 1966, for evaluation of the Lightning as a target facilities aircraft. The FCTU disbanded on 30 June 1967, and its two specially modified 'target' Lightning F.Mk 1s were transferred to a newly established independent Binbrook TFF. The F.Mk 6s went to No. 23 Squadron.

This FCTU F.Mk 1 target aircraft wore the Binbrook lion.

Binbrook Target Facilities Flight

The Binbrook TFF formed by the redesignation of what had been the FCTU at Binbrook in June 1967. The first F.Mk 1A was taken on charge in January 1968, although the newer variant did not finally supplant the original F.Mk 1 at Binbrook until mid-1971. The unit was subsequently absorbed by No. 5 Squadron late in 1970. The Binbrook TFF was reformed in 1972 from the Target Facilities Flight previously attached to No. 5 Squadron, with an F.Mk 1 and two F.Mk 1As coded 'X', 'Y' and 'Z'. Like the other TFFs, the unit disbanded on 31 December 1973 and its aircraft were put out to grass as decoys, later being used to test different camouflage schemes being considered for the front-line Lightning fleet.

The TFFs were disbanded as an economy measure, largely to save the expense of having to support a separate variant (the F.Mk 1/F.Mk 1A) at bases operating F.Mk 3s or F.Mk 6s.

It was originally planned to apply nose markings like those of No. IV Squadron to the Binbrook TFF Lightnings, with segments of blue and Lincoln green divided by a diagonal lightning flash. In the event, the unit used simple blue nose bars, outlined in white, with Binbrook's lion badge in blue on a white disc on the tail.

The Binbrook TFF had two lives, the target work being undertaken by No. 5 Sqn in the intervening period.

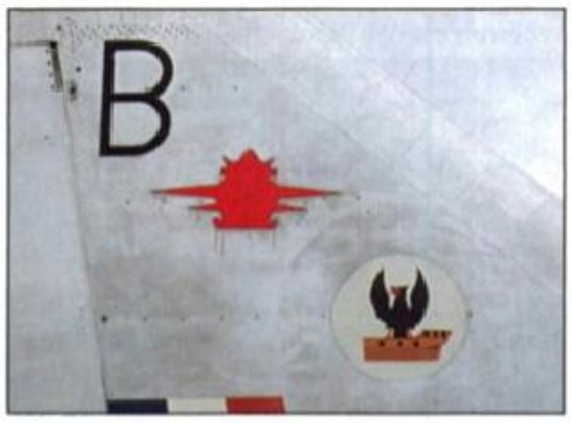
Leuchars Target Facilities Flight

The Leuchars TFF formed in April 1966, and had three F.Mk 1s on charge by September. The first F.Mk 1A was taken on charge in October 1968, although the F.Mk 1 remained in use alongside the newer variant for the whole of its life. Aircraft initially wore an adaptation of the Leuchars Station badge (a St Andrew's Cross with a sword, against blue and white 'waves') on their fins, with the 'last three' large on the nose. The tail markings remained in use, but new nose markings, consisting of red-edged yellow bars, with red lions, were added on each side of the nose roundel. These markings led some to describe the TFF as the 'Royal Scottish Air Force'. The Leuchars TFF was absorbed by No. 23 Squadron in early 1972, and the unit served on as part of No. 23 Squadron until 31 December 1973, when the TFF disbanded. The F.Mk 1s and F.Mk 1As at Leuchars were retired soon afterwards. A single F.Mk 6 operated by the Leuchars Station Flight during February 1976 briefly wore similar markings to the TFF aircraft, with red lions on pale blue nose bars, and with a red lion on a white square centred on a pale blue St Andrew's flag on the tailfin.

The 'Royal Scottish air force' was in operation with a handful of F.Mk 1s (illustrated) and 1As on target duties until 1972.

Wattisham Target Facilities Flight

The Wattisham TFF was the second such unit to form, in March 1966, taking three refurbished and modified F.Mk 1s from No. 33 MU. The Lightning's twin jetpipes mounted one above the other reminded some of a cat, when seen from directly behind, and a rear view of a cat (with wings and tailplanes, tail erect serving as a fin) became the Wattisham TFF's unofficial badge. This was inevitably applied to the noses of its aircraft, and sometimes replaced the official eagle and galleon insignia on the tailfin. Yellow, black and yellow nose bars were carried on each side of the roundel. The TFF aircraft were briefly named after famous cats during the late 1960s, *Korky*, *Felix* and *Jinx* all being noted. When it disbanded on 31 December 1973, the Wattisham TFF had two F.Mk 1s and an F.Mk 1A on charge.



Wattisham TFF aircraft wore the station badge and the 'Wattisham Cat' on the fin, in addition to black and yellow nose bars.

Lightning Training Flight

When No. 226 OCU disbanded at the end of September 1974, the Lightning force (five squadrons had more than a year left to run) was left without a training unit. 'C' Flight of No. 11 Squadron was formed (with about five T.Mk 5s) to fill the gap, but it soon became apparent that a dedicated training unit was still needed. It was clear that the two squadrons in RAF Germany would not last beyond 1977, but the Binbrook wing seemed set for many years of service. No. 11 Squadron's 'C' Flight gained its independence as the Lightning Training Flight at the beginning of October 1975, with four T.Mk 5s and four F.Mk 3s on strength. From 1979, the Flight usually had a single high-time F.Mk 6 on charge, and this was used as a supersonic target, with its radar temporarily replaced by a Luneberg lens, and with an extra fuel tank replacing the ventral gun pack. The LTF disbanded in April 1987, with the end in sight for the whole Lightning force. No further pilots, instructors, QWIs or IREs would be trained, the F.Mk 3s were retired, and the T.Mk 5s were scrapped or transferred to the two front-line squadrons.

The LTF used markings similar to those originally applied to the Binbrook TFF, with blue nose bars and the Binbrook lion in blue on the fin. This creature was very much larger than it had been on the TFF aircraft, and was edged in red, with a yellow fleur-de-lys on its chest. The letters LTF were applied above the lion on the fin, these also

After a year of being parented by No. 11 Sqn, the Lightning training effort regained its autonomy in late 1975.

being edged in red. In later years, some of the aircraft had smaller markings, with the blue lion in a tiny disc on the fin, flanked by miniature blue bars, and with nothing on the nose. Much larger markings appeared again in October 1985, to celebrate the LTF's 10th anniversary. One F.Mk 3 received a blue fin and spine, with an oversized lion in a huge white disc on the fin.

Above: For a short time, the LTF's aircraft wore much brighter blue markings than normal. F.Mk 3s were used alongside T.Mk 5s.

Right: The LTF survived long enough for some of its aircraft to receive air defence grey camouflage.

Lightning Augmentation Force

After plans to reform a third front-line squadron within the Binbrook wing fell through, the continuation training of former Lightning pilots undergoing ground tours assumed a greater significance, since they would have formed a war reserve. These pilots formed the Lightning Augmentation Force from late 1981, and flew aircraft being rotated between storage, the LTF and the two front-line squadrons. The LAF was never allocated any aircraft of its own, although a handful of the Binbrook wing Lightnings briefly wore temporary LAF markings made from Dayglo tape.

This F.Mk 6 wears the temporary markings of the LAF on the fin.

No. 33 MU

No. 33 MU at Lyneham was a major centre for Lightning storage, modification and overhaul work, but never had its own aircraft permanently assigned. The unit did not even have a permanent test pilot, which led to one aircraft making an involuntary flight when a resident engineering officer (whose previous piloting experience was confined to the Chipmunk) accidentally engaged reheat during high-power engine runs. The aircraft rapidly started to run out of runway, so the 'pilot' opted to take off. He had no option but to land, since the aircraft had no serviceable ejection seat. Fortunately he got down safely, without severely damaging the aircraft, after four missed approaches or landing attempts. He was wearing no helmet, so could not communicate with ATC, but did have the Pilots' Notes on the cockpit coaming!

Akrotiri Station Flight

A single T.Mk 5 from No. 56 Squadron (XS452) was left in Cyprus when the Firebirds returned to the UK. Assigned to the Station Flight at RAF Akrotiri, the aircraft had a pink fin and spine, with blue-edged pink rectangles flanking the roundel, and with the station's flamingo badge on the tail. The aircraft was used primarily by UK-based Lightning squadrons visiting Cyprus for APCs, and returned to the UK on 21 May 1975.

One of the most famous Lightning colour schemes was that which appeared briefly on XS452 during 1975. The aircraft was painted in January 1975 with these markings for the Akrotiri Station Flight, but was returned to Binbrook for storage in May. In July it was assigned to No. 11 Sqn's 'C' Flight, repainted in an experimental dark-green scheme.

No. 60 MU

For most of the Lightning's career, the primary maintenance unit involved in maintenance, modification, storing (and eventually scrapping) Lightnings was No. 60, at Leconfield. The unit usually maintained a Lightning in flying condition to allow the unit's test pilots to remain in current flying practice, and a number of these aircraft wore special markings.

F.Mk 1 XM144 wore a simplified version of the station badge (a quiver of arrows on a pale blue disc) on its tailfin, with a large red and gold arrow (bisected by the roundel) on a dark-blue-edged pale blue rectangle. The aircraft was replaced by an F.Mk 6 which wore similar markings. A T.Mk 4 was also in use. No. 60 MU's final Lightning was XM135, an F.Mk 1 retired to the IWM at Duxford on 20 November 1974, the last F.Mk 1 to fly.

Left: Between July 1974 and July 1976, T.Mk 4 XM970 was No. 60 MU's hack.

Below: No. 71 MU used this T.Mk 4 for maintenance duties.

Empire Test Pilots' School

The A&AEE at Boscombe Down used a variety of Lightnings for trials and development work, but none was permanently assigned for any length of time once the initial development push (with the early P.1Bs) was over. The Boscombe Down-based ETPS, however, was a long-term Lightning user. The unit used T.Mk 4 XL629 '23' from 13 May 1966 until 3 November 1975. It was replaced by T.Mk 5 XS422 until it, too, ran out of airframe hours in September 1987.

XS422 was the second Lightning used by the ETPS. It provided fast-jet experience until replaced by a Tornado F.Mk 2 in 1987.

BAe Warton

As BAC's Military Aircraft Division, the Warton Flight Test department operated countless Lightnings for development work and for production test flying, as well as for chase duties on other programmes. One F.Mk 2 (XN795, subsequently converted to F.Mk 2A standards) and one F.Mk 3 (XP693, which became a virtual F.Mk 6) served at Warton from 1962, eventually being fitted with the Tornado's 27-mm Mauser cannon for firing trials, then being used as a chase aircraft in support of Tornado and EAP. Remarkably, more examples of the Lightning returned to Warton long after production had ended. During 1988 six Binbrook Lightnings were fitted with overwing fuel tanks for extended endurance operations, acting as radar targets for Tornado ADV prototypes over the Aberporth range. They usually flew in pairs from Warton, where they deployed for up to a week at a time. The requirement for Lightning targets would clearly last longer than the RAF Lightning fleet, and, accordingly, four of the tank-equipped aircraft were delivered to Warton from 12 April 1988 to augment BAe's existing Lightning, XP693. They served as high-speed targets for Tornado ADV radar development work, operated by BAe under an MoD (PE) contract which lasted until 17 December 1992.

Above: Led by BAe's long-serving XP693, the last three flying Lightnings undertake a three-ship farewell tour from Warton in December 1992.

Left: Following the end of Lightning development work, BAe used XP693 (later joined by ex-RAF machines) for radar target duties in conjunction with the Tornado ADV programme.

Royal Saudi Air Force

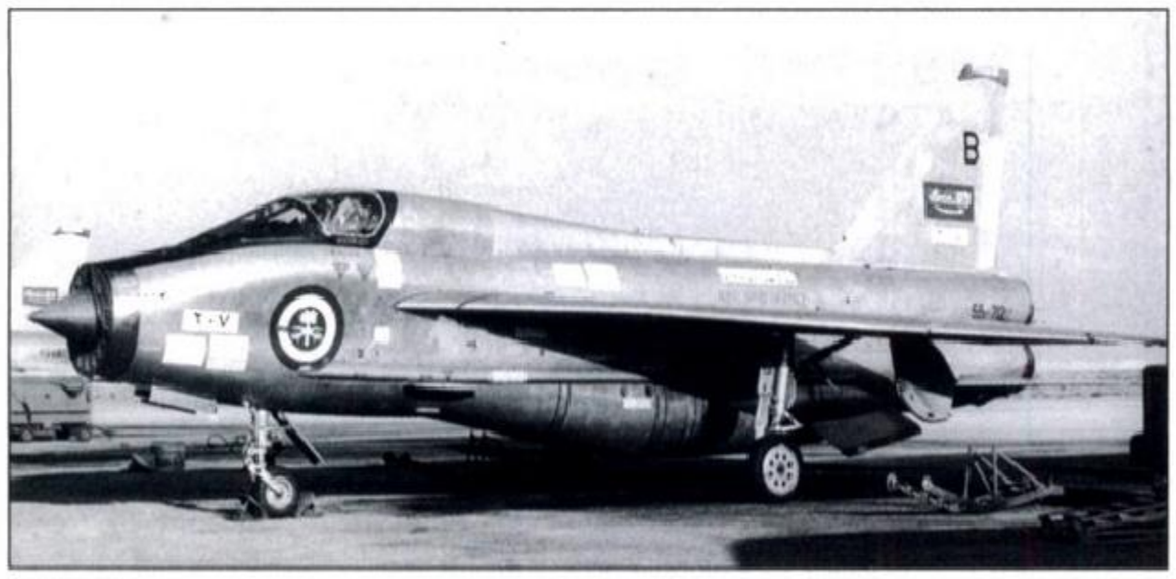
With Saudi Arabia facing insurgency from neighbouring Yemen, the Kingdom was targeted by BAC as a potential Lightning customer. The sales campaign was headed by Geoffrey Edwards, a British expatriate businessman, who found the Saudis eager to talk, especially after the Wilson government came to power in 1964, and after an RAF F.Mk 2 on detachment in Cyprus was borrowed by BAC for a 4 July display in Jeddah, flying via Bahrain. After an evaluation by one Saudi pilot at Warton (including a solo flight during which he out-ran his F.Mk 3 chase), a contract was signed on 21 December 1965.

Under Operation Magic Carpet, the Saudis received five ex-RAF F.Mk 2s and two T.Mk 4s as F.Mk 52s and T.Mk 54s (with an early F.Mk 1 development aircraft – XG313/G-27-115 – as a ground instructional airframe). They were used for ground- and aircrew familiarisation, and to combat Yemeni (and Egyptian) incursions, for which they were deployed to Khamis Mushait. Incursions by Egyptian aircraft ceased immediately, but the Lightnings did see action in the air-to-ground role, combating incursions by Yemeni ground units.

Operation Magic Palm covered the supply of 35 F.Mk 53s (including one attrition replacement for a pre-delivery loss) and seven T.Mk 55s (with another replacement for a pre-delivery loss). Initial plans called for Saudi Arabia's Lightnings to equip Nos 1, 2 and 3 Squadrons at Dhahran, with No. 6 Squadron at Khamis Mushait to be part-manned by loaned Pakistani pilots. In fact, when delivered, the Lightnings went to No. 2 Squadron at Dhahran, No. 6 Squadron at Khamis Mushait and No. 13 Squadron at Dhahran. The Khamis Mushait F.Mk 53s saw service again between December 1969 and May 1970, during a border dispute with Yemen, which included some incursions. The Lightnings flew ground attack sorties using bombs and 2-in rockets, halting a column on one occasion and prompting its surrender to Saudi ground forces. One Lightning was shot down by ground fire over Yemeni territory on 3 May 1970. The pilot ejected safely, and was picked up by a Saudi C-130 Hercules, covered by more Lightnings.

The Lightning officially retired from Saudi service in December 1986, and 22 of the survivors were flown back to Warton by RAF pilots on 14 January 1986, for possible resale. Seven more aircraft were left in Saudi Arabia on display, after premature retirement. Of the 47 aircraft delivered (two more were lost before delivery), 18 were lost in service (one written off after a starter fire on the ground, and another after being hit by ground fire). There were reports that a handful of Lightnings remained airworthy after the return of the 22 survivors to the UK, these apparently serving as Tornado radar targets. This seems most unlikely, since the other survivors had been grounded in 1984, and were not returned to the UK because of their poor condition or use as gate guards.

Saudi Lightnings were delivered in natural metal finish, with national insignia consisting of a flag-type fin flash and Saudi roundels on the nose and above the port and below the starboard wings, with RSAF above the starboard and below the port wings. The legend ROYAL SAUDI AIR FORCE was applied in English and in Arabic along the aircraft spine. No unit markings were applied. A handful of aircraft (all from No. 6 Squadron) were camouflaged, but the new scheme was not adopted fleet-wide.



Most of the T.Mk 55s were operated by the LCU (left), this example being seen at Dhahran. Few of the F.Mk 53s (below) ever publicly wore squadron badges.

Serial numbers were applied USAF style with a 52, 53, 54 or 55 prefix (though these related to mark number and not FY of acquisition) followed by a three-digit consecutive number. By 1970, the Lightnings carried their squadron serial (consisting of a squadron numerical prefix and a two-digit serial) in a white rectangle which was joined to the bottom of the fin-flash, and had a heraldic squadron badge (similar to an RAF unit badge, but with a Saudi crown) below it. The original FY-type serial number was eventually dropped altogether, and larger, more stylised squadron badges were applied. The last aircraft in service with No. 2 Squadron carried a single letter code, not a serial.

Lightning Conversion Unit

The LCU was apparently initially based at Jeddah, where most of the early Saudi Lightnings were delivered directly. The unit probably moved to Dhahran before many aircraft had been received, though aircraft still arrived in Saudi Arabia at Jeddah, where BAe prepared them for service. Some reports suggest that the LCU was at Khamis Mushait by December 1969. The LCU reportedly moved to Riyadh on 26 November 1972, and was probably based at Dhahran by 1975, although some reports suggest that it was based for some years at Khamis Mushait. The LCU probably disbanded in the late 1970s or early 1980s, and it is likely that a dedicated flight of No. 13 or No. 2 Squadron took over its functions, or it may have been absorbed by No. 6 Squadron at Khamis.

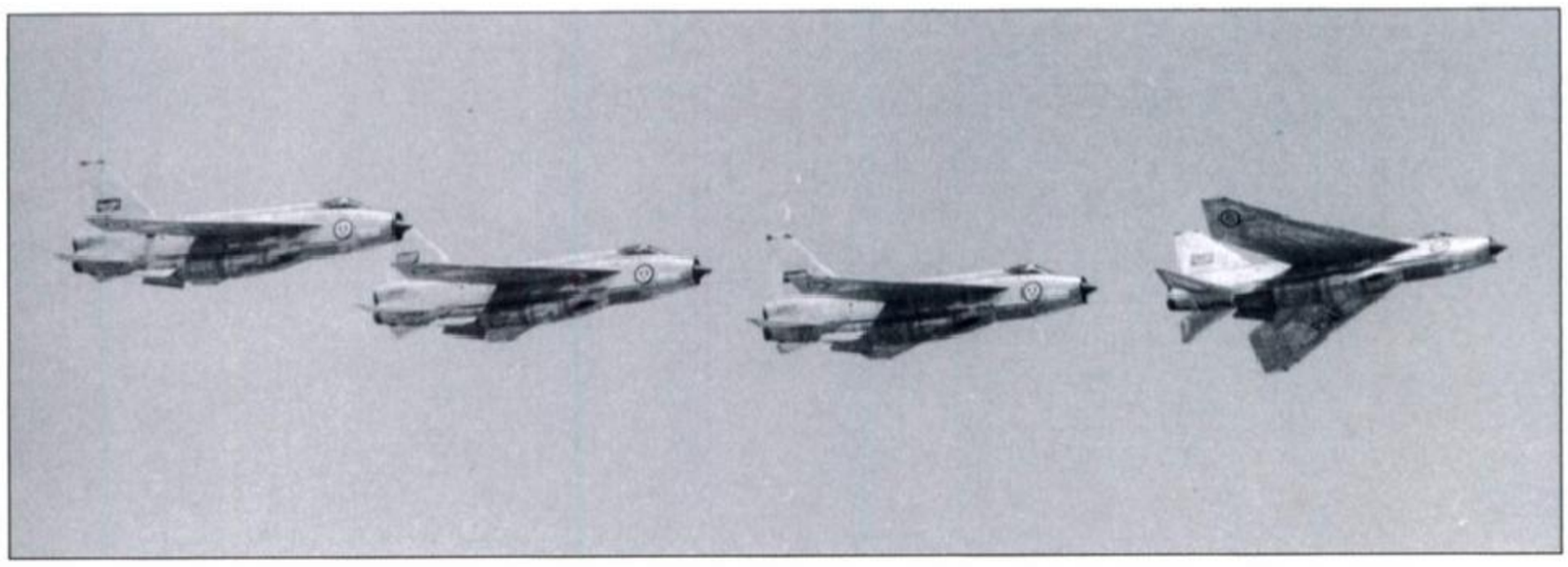
No. 2 Squadron

No. 2 Squadron was probably the second Saudi Lightning squadron and was initially based at Dhahran, but subsequently moved to Tabuk, probably on 25 November 1976. The squadron used serials commencing 201, and later switched to single letter codes. No. 2 Squadron was the final Saudi operator of the Lightning, and the type was officially withdrawn from use in December 1985. No. 2 Squadron has not reformed since losing the Lightning, and remains in limbo. No. 2 Squadron's aircraft wore a small heraldic crest below the fin flash, with the centrepiece being a hand holding a lightning bolt.

No. 6 Squadron

No. 6 Squadron became the first RSAF Lightning unit when it took delivery of the ex-RAF F.Mk 2s and T.Mk 4s delivered under Operation Magic Carpet from 10 July 1966. From 7 August 1967 the unit was forward-deployed to Khamis Mushait, which was then a somewhat primitive and austere base with few facilities. The squadron's primary base was probably Riyadh, where training and conversion was carried out. No. 6 Squadron operated the original five F.Mk

This is the No. 2 Sqn badge. The Arabic legend translates as 'Maybe the Lightning will pull their sight'.



52s, and probably the two T.Mk 54s, later gaining a number of F.Mk 53s, including some operating on short-term loans. Maintenance was provided by Airwork, with some British pilots, and the Pakistani air force took over on 31 March 1968 when the Magic Carpet contract expired. This proved unsatisfactory, and Airwork was soon given a new contract. The squadron apparently initially used serials commencing 301, instead of 601 as would have been expected. No. 6 Squadron was reported to have moved from Khamis Mushait to King Abdul Aziz AFB (Dhahran) in June 1976, but if so this was a temporary move. The squadron converted to the F-15 during July-December 1983, remaining at Khamis Mushait.

Serial	previous identities	c/n
F.Mk 52 (five conversions from F.Mk 2)		
52-655	XN767, later reserialled 52-609	95115
52-656	XN770, later reserialled 52-610	95123
52-657	XN796	95149
52-658	XN797, later reserialled 52-611	95150
52-659	XN729, G-27-1, later reserialled 52-612	95106
F.Mk 53 (1 conversion from F.Mk 3, 34 production aircraft)		
53-666	XR722, G-27-2	95205
53-667	G-27-37	95272
53-668	G-27-38, to BAe as ZF577	95273
53-669	G-27-39	95274
53-670	G-27-40, to BAe as ZF578	95275
53-671	G-27-41, to BAe as ZF579	95276
53-672	G-27-42, to BAe as ZF580	95277
53-673	G-27-43	95278
53-674	G-27-44	95279
53-675	G-27-45, to BAe as ZF581	95280
53-676	G-27-46, to BAe as ZF582	95281
53-677	G-27-47	95282
53-678	G-27-48	95283
53-679	G-27-49, to BAe as ZF590	95284
53-680	G-27-50	95285
53-681	G-27-51, to BAe as ZF583	95286
53-682	G-27-52, to BAe as ZF584	95287
53-683	G-27-53, to BAe as ZF585	95288
53-684	G-27-54	95289
53-685	G-27-55, to BAe as ZF591	95290
53-686	G-27-56, G-AWON, to BAe as ZF592	95291
53-687	G-27-57, G-AWOO	95293
53-688	G-27-58, to BAe as ZF586	95294
53-689	G-27-59	95295
53-690	G-27-60	95296
53-691	G-27-61, to BAe as ZF587	95297
53-692	G-27-62, to BAe as ZF593	95298
53-693	G-27-63, to BAe as ZF588	95300
53-694	G-27-64	95301
53-695	G-27-65	95302
53-696	G-27-66, to BAe as ZF584	95303
53-697	G-27-67	95304
53-698	G-27-68	95305
53-699	G-27-69	95306
53-700	G-27-223, to BAe as ZF589	95317
T.Mk 54 (2 conversions from T.Mk 4)		
54-650	XM989, later reserialled 54-607	95077
54-651	XM992, later reserialled 54-608	95080
T.Mk 55 (1 conversion from T.Mk 5, 6 production aircraft)		
55-710	XS460, G-27-70 (lost before delivery)	95020
55-711	G-27-70, to BAe as ZF597	95024
55-712	G-27-71	95025
55-713	G-27-72, to BAe as ZF598	95026
55-714	G-27-73, to BAe as ZF595	95027
55-715	G-27-74, to BAe as ZF596	95028
55-716	G-27-75	95030

No. 13 Squadron

There were very few sightings of No. 13 Squadron Lightnings, and it seems likely that the Dhahran-based unit was relatively short-lived. It used serials commencing 1301. The squadron was certainly active at Dhahran between 1978 and 1982, and may have formed at Dhahran to replace No. 2 Squadron when the latter unit moved to Tabuk. No. 13 Squadron was the first RSAF F-15 unit, converting to the new type from the Lightning in June 1982. No. 13 Squadron's Lightnings wore a unit badge on the tailfin, consisting of a hovering eagle on a buff-coloured disc on a black shield, on which a Saudi crown and motto were also superimposed.

The LCU operated F.Mk 53s alongside the two-seaters. The training unit is believed to have moved base several times.

No. 6 Squadron was the first Saudi unit to convert, using its aircraft in action. Along with No. 13, it converted to the F-15 in the early 1980s.

Kuwait Air Force

Kuwait received 12 Lightning F.Mk 53Ks and two T.Mk 55Ks (55-410/G-27-78 and 55-411/G-27-79), the batch being delivered between December 1968 and December 1969. The Kuwaiti Lightnings were operated from Kuwait International airport, which was sufficiently busy to severely limit operations. An attempt was made to operate from newly built bases at Ahmed al Jaber and Jakra, but neither had adequate infrastructure. Consequently, the Kuwaiti air force found it particularly difficult to keep the Lightnings serviceable, let alone operational, and they were offered for sale in 1973 although potential purchasers (including Egypt) were put off by the poor condition of some of the aircraft. Some Lightnings remained in use until 1977, when they were finally replaced by Dassault Mirage F1s. Three Kuwaiti Lightnings were lost in accidents, and another was grounded due to damage caused in a ground accident. This aircraft and three others were stored at Kuwait airport, three were displayed at Ahmed al Jaber and one at Ali Salem AFB, while the two-seaters ended up on display at the University and the Messila Beach O-club. At least two of the aircraft at al Jaber survived the Gulf War, but others may have been destroyed.

The markings remained consistent throughout the aircraft's short career, comprising large roundels above and below both wings and on the nose, and large fin flashes. The FY-style serial was presented on the rear fuselage, the last three digits being repeated in Arabic numerals below the fin-flash and forward of the nose roundels. A single code-letter was presented in black above the fin-flash.

Below left: Kuwait used its Lightnings only sparingly, with the result that many were available for display purposes after their replacement by the Mirage F1.

Below: Two T.Mk 55K two-seaters were supplied with the Kuwaiti batch. The force flew primarily from Kuwait City airport.

Serial	Tailcode	Previous identity	c/n
T.Mk 55K (2 production aircraft)			
55-410	A	G-27-78	95023
55-411	B	G-27-79	95029
F.Mk 53K (12 production aircraft)			
53-412	C	G-27-80	95292
53-413	E	G-27-81	95299
53-414	F	G-27-82	95307
53-415	H	G-27-83	95308
53-416	J	G-27-84	95309
53-417	K	G-27-85	95310
53-418	L	G-27-86, G-AXEE	95311
53-419	M	G-27-87, G-AXFW	95312
53-420	N	G-27-88	95313
53-421	O	G-27-89	95314
53-422	P	G-27-90	95315
53-423	R	G-27-91	95316

Unit Heritage

The Atomic Bombers

The 509th Bomb Group in World War II

Seen resting on Tinian in 1945,* Enola Gay *is probably the most famous military aircraft in history, challenged in the public's mind only by the Red Baron's Fokker Triplane. Essentially little different from thousands of other B-29s, its mission to Hiroshima and the huge effort to develop the atomic bomb it carried represent the ultimate expression of war waged on industrial lines.

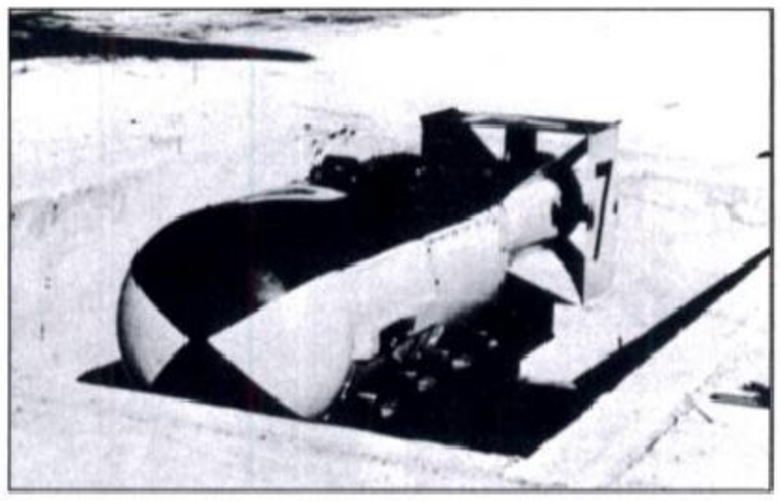
By mid-1945 there were few large cities in Japan that had not been razed by the conventional bombs and incendiaries of XXI Bomber Command. Those that had been spared were earmarked for the atomic bombs of the 509th CG. This is Hamamatsu near Nagoya, destroyed by the 73rd Wing on the night of 17/18 June.

In early 1944, an obscure USAAF unit was raised on the salt flats of Utah. Eighteen months later, this small band would unleash the weapons that would end a global conflict and influence nations to the present day. Never in history has one small military formation had such a decisive effect on war and on history itself.

Over the past 200 years, most of the heroes and legends who the United States has produced have been connected to war and the military. The public's infatuation with the aeroplane increased the media exposure of the fighter pilot, and names like Eddie Rickenbacker, Dick Bong and James Jabara became household names in their times. Hundreds of 'kills' were recorded by only a select few, who became legends; their exploits have been 'etched in stone' for future generations to read. It might have taken thousands of missions for the relatively small fraternity of fighter aces to achieve their kills and, individually, none of them could be considered a decisive factor in winning any war. They were merely above-average fighter pilots who captured the imagination of the public.

However, on the small island of Tinian in 1945, a small band of sky warriors did achieve such a distinction. They operated 15 specially modified B-29s, two of which delivered the decisive blows that ended a bloody war and saved hundreds of thousands of lives (military and civilian) by preventing the invasion of Japan. They were the elite 509th Composite Bomb Group and they delivered the two atomic bombs that hastened the end of World War II and ushered the world into a new era of warfare.

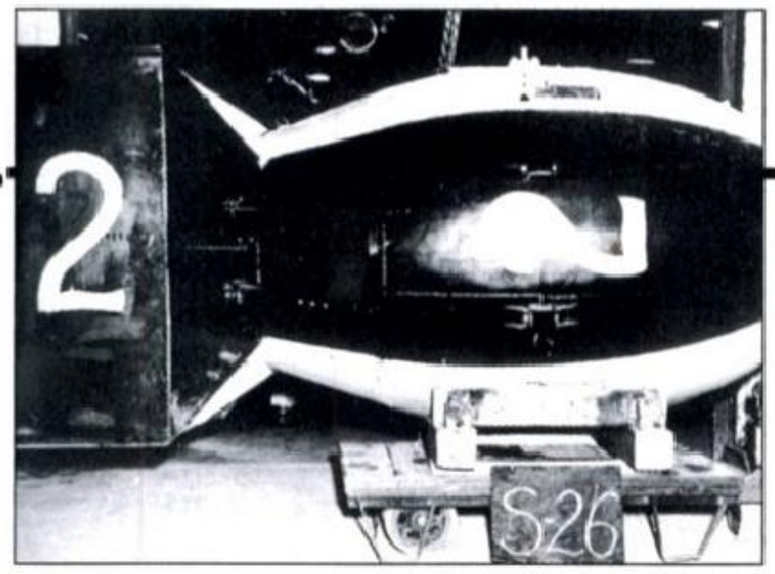
Left and below: Working up at Wendover, Utah, the 509th dropped dozens of test A-bomb shapes over the Salton Sea range in California to verify fall characteristics and fusing. These pictures show 'Little Boy' shapes and the loading pit needed to get the bomb aboard the B-29 with its low-slung bomb doors.



The 'gimmick'

The formation of the B-29 group that would deliver the bomb dated to the early months of 1944. It was not a project that was thrown together on a whim. In June 1944, Colonel Paul Tibbets was informed that he would command a special bomb group that would drop the world's first atomic bomb. Tibbets alone knew the details. From his assistant, Lieutenant Colonel Thomas Classen, down through the ranks, it was concluded that they were to drop a special type of bomb which they referred to as 'the gimmick'. The project was so hush-hush that it redefined the words 'top secret'.

The next step was to select the squadron that would fly the modified B-29s and drop the bomb. The 393rd Bomb Squadron had completed two-thirds of its training as a member of the 504th Bomb Group at Fairmount AAF (Army Air Field), Nebraska. In



Above: This is a test model of the 'Fat Man' plutonium bomb used for drop tests in late 1944/early 1945. The high-visibility markings helped ground observers track the fall of the weapon and a small explosive charge indicated a correctly-set fuse. One of these 9,000-lb (4082-kg) shapes narrowly missed the town of Calipatria, California in March 1945.

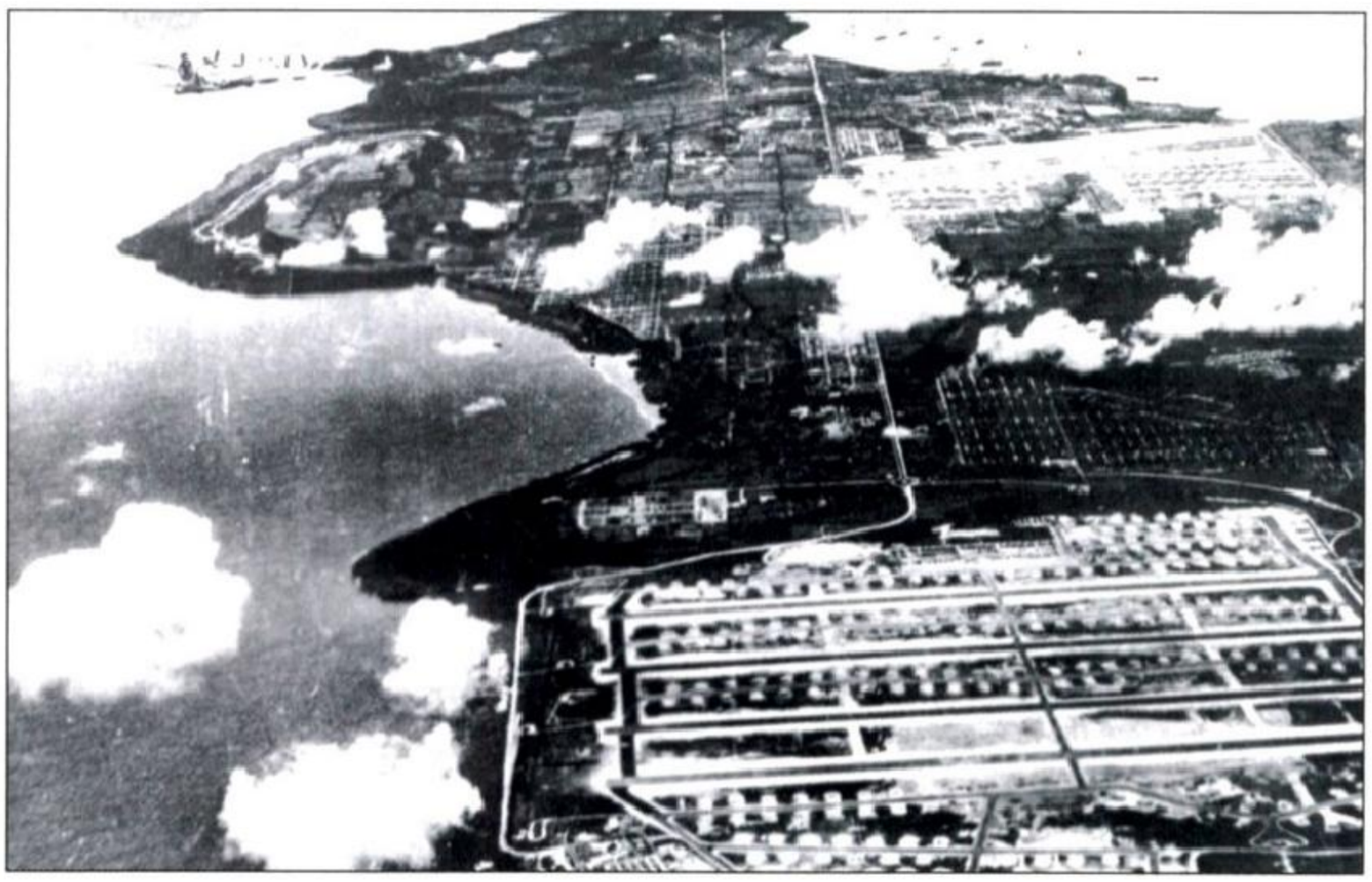
Above right: Nine of the 509th's B-29s were sent to Batista Field, Cuba in January 1945 for an intensive period of overwater navigation exercises. This is the crew of* The Great Artiste, *making the best of their break from the Utah salt flats in Sloppy Joe's Bar, Havana. This crew would later drop the atom bomb on Nagasaki.

October 1944, just as the 504th received orders to proceed to the Pacific for combat, the 393rd BS was held back and told to report to Wendover AAB, Utah for additional training.

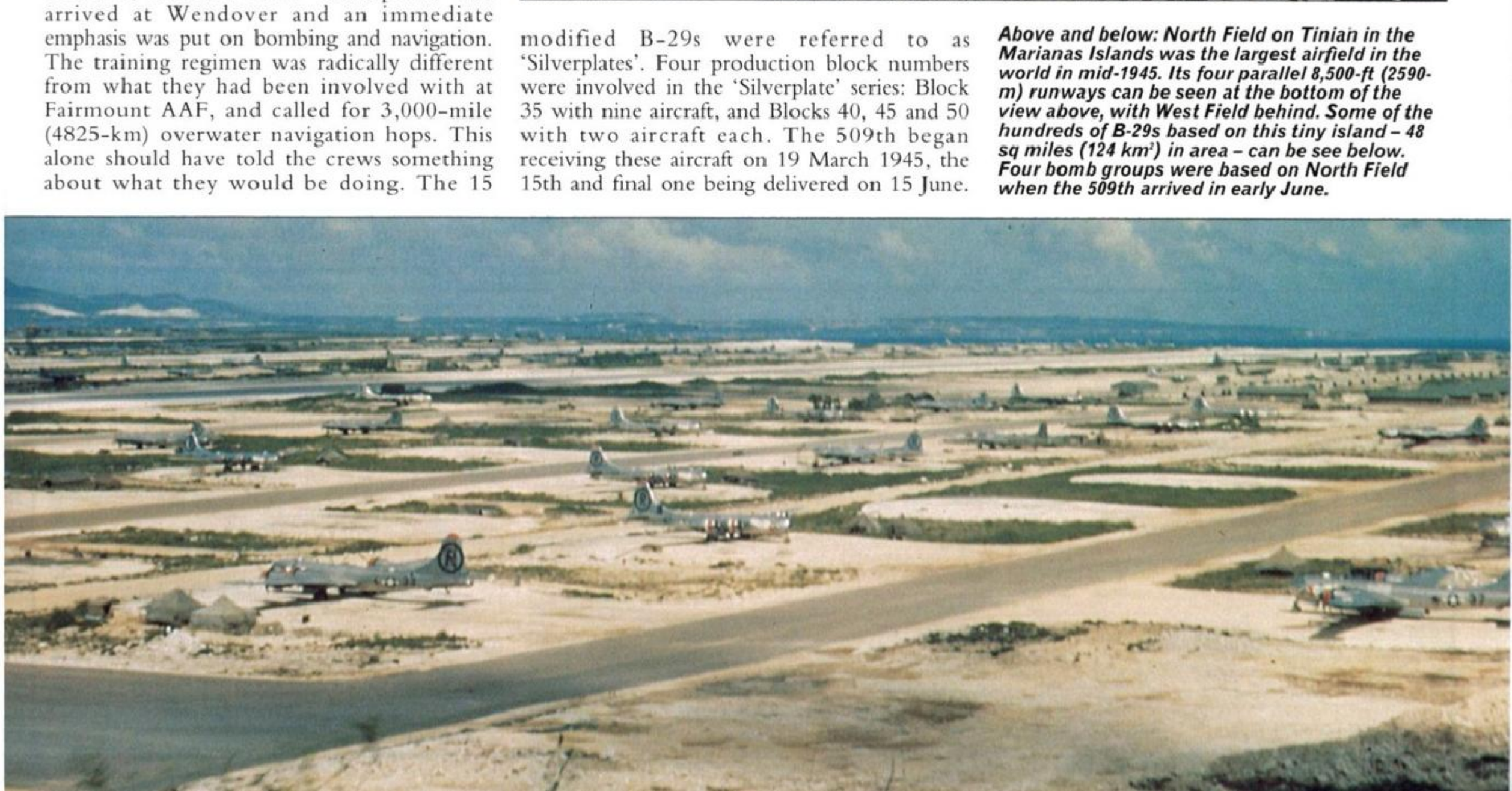
The troops arrived at Wendover, in the middle of the salt flats, not knowing what they would be doing. Some came by rail, others by car and a fortunate few by air. Upon arrival, they were introduced to their new commander, Colonel Tibbets. At this point, they were told that they had been selected to be involved in a top-secret project that might shorten the war by at least one year. Tibbets emphasised the need for complete secrecy.

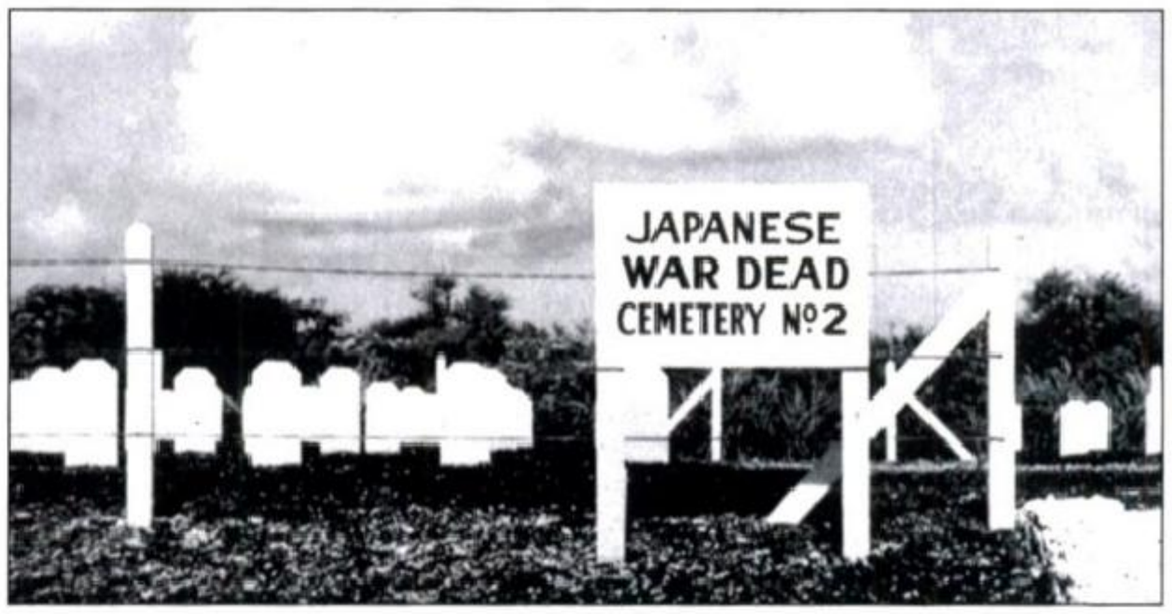
'Silverplate' Superforts

Over 2,000 men had been interviewed for membership within this special unit. Of these, one-third were rejected. Only the best in each position had been accepted. By the end of October, two new B-29 'Silverplates' had arrived at Wendover and an immediate emphasis was put on bombing and navigation. The training regimen was radically different from what they had been involved with at Fairmount AAF, and called for 3,000-mile (4825-km) overwater navigation hops. This alone should have told the crews something about what they would be doing. The 15 modified B-29s were referred to as 'Silverplates'. Four production block numbers were involved in the 'Silverplate' series: Block 35 with nine aircraft, and Blocks 40, 45 and 50 with two aircraft each. The 509th began receiving these aircraft on 19 March 1945, the 15th and final one being delivered on 15 June.



Above and below: North Field on Tinian in the Marianas Islands was the largest airfield in the world in mid-1945. Its four parallel 8,500-ft (2590-m) runways can be seen at the bottom of the view above, with West Field behind. Some of the hundreds of B-29s based on this tiny island – 48 sq miles (124 km²) in area – can be see below. Four bomb groups were based on North Field when the 509th arrived in early June.





Above and above right: For the US Marines, Tinian was just another island on the way towards the eventual invasion of Japan. Casualties in the eight-day battle for the island amounted to around 200 dead. The Japanese lost over 9,000 soldiers, but another 500 hid on the island for the duration of the war, making occasional guerrilla raids on the US bases and taking food from their abundant waste dumps.

The nose art on* Top Secret *(above) (piloted by Captain Charles McKnight) and* Strange Cargo *(below) (Captain Joseph Westover) hinted at a special mission for the 509th CG. Rumour was rife on Tinian about the new group and its purpose. Security was so tight that few members of the 509th were much wiser.

It took 90 days to complete the complement.

Each aircraft was rigged with high-strength internal support structures, and had a massive shackle for holding and releasing a 5-ton bomb, by a single lug. A sway brace was also installed to prevent dangerous lateral or longitudinal movement of the bomb within the forward bomb bay compartment, where the bomb was to be carried. The bombers also had been fitted with a pneumatic mechanism that would allow quick opening and closing of the bomb bay doors.

Extensive electronic gear was installed. This was intended not only for bomb monitoring and control, but also for measurement of the energy released on detonation, which would be monitored by the instrument aircraft that was accompanying the bomb-carrying B-29. One of the support aircraft was also to carry parachute-retarded instrument packages to drop over the target area. Data from these would be transmitted to and recorded by the support aircraft.

Reversible bomber

Fuel injection was utilised, instead of carburation, to facilitate the even distribution of fuel to the 18 cylinders of the Wright R-3350 2,200-hp (1640-kW) radial engines, resulting in better fuel economy and cooling. Each powerplant had the new Curtiss electric propellers that employed reverse-pitch and synchronisation, an innovation that greatly reduced stopping distance upon landing because it used the propellers as brakes. It even allowed the big bomber to be backed over a loading pit or onto a hardstand under its own power. The synchroniser enabled the pilot to maintain a consistent RPM in all four engines by the simple twist of a knob. Cuffs near the hub on the propeller blades also contributed to the increase in the flow of air around the engines, for better cooling.

All of the above modifications were internal, so to speak, and would go unnoticed to anyone looking from a distance. Much more conspicuous was the lack of gun turrets and sighting blisters on the fuselage; the only defensive armament was twin 0.50-in calibre guns mounted in the tail turret. The mission of the 509th was not to fight its way to the target, but to fly lone-ship missions, with plenty of altitude and speed.

As 1944 came to a close, the war seemed endless, and the training of the 509th increased in intensity. Long-range planners were deeply entrenched in devising the details for the inevitable invasion of Japan.

During late November and early December, the 393rd concentrated on making bomb runs at a nearby range to test the ballistic qualities of various experimental models of the bomb, each loaded with an inert filler. Their training programme went far beyond that of a regular bomb squadron. Using the Norden bombsight, crews of the 509th could hit a 500-ft (150-m) circle from 30,000 ft (9145 m). As a result of the training and extra maintenance precautions, the group did not lose a man or an aircraft in training or in combat operations.

On 17 December 1944, formal orders were cut which activated the 509th Composite Group. At the time, there was no such designation in the USAAF, and the unique title increased the mystique surrounding the new unit. An additional 800 men were brought into the support units within the parent organisation. At this time, the 393rd was moved to Batista

'Silverplate' B-29s of the 509th Composite Group

Model	Serial	Name	Victor no.	Assigned pilot	Markings	Missions	Fate
B-29-35-MO	44-27296	*Some Punkins*	V-84	Capt. James N. Price	497th BG	5 Pumpkins	Damaged in ground collision. Scrapped Aug 1946
B-29-35-MO	44-27297	*Bockscar*	V-77	Capt. Frederick C. Bock	444th BG	2 Pumpkins, Nagasaki A-bomb aircraft	To USAFM September 1961
B-29-35-MO	44-27298	*Full House*	V-83	Maj. Ralph R. Taylor	39th BG	5 Pumpkins, weather recon 6 August	To China Lake 1956. Eventually scrapped.
B-29-35-MO	44-27299	*Next Objective*	V-86	Maj. Ralph N. Devore	444th BG	3 Pumpkins	Scrapped 1949
B-29-35-MO	44-27300	*Strange Cargo*	V-73	Capt. Joseph E. Westover	497th BG	4 Pumpkins	Target tug. Scrapped 1957
B-29-35-MO	44-27301	*Straight Flush*	V-85	Maj. Claude R. Eatherley	444th BG	5 Pumpkins, weather recon 6 August	Target tug. Scrapped 1954
B-29-35-MO	44-27302	*Top Secret*	V-72	Capt. Charles F. McKnight	497th BG	6 Pumpkins	Radar calibration. Scrapped 1954
B-29-35-MO	44-27303	*Jabitt III*	V-71	Capt. John A. Wilson	497th BG	4 Pumpkins, weather recon 6 August**	Scrapped 1946
B-29-35-MO	44-27304	*Up an' Atom*	V-88	Capt. George W. Marquadt	444th BG	5 Pumpkins, weather recon 9 August	Target tug. To China Lake 1956. Eventually scrapped
B-29-40-MO	44-27353	*The Great Artiste*	V-89	Capt. Charles D. Albury	6th BG	2 Pumpkins, instrument ship 6 and 9 August	Radar Calibration. Scrapped 1960
B-29-40-MO	44-27354	*Big Stink*	V-90	Capt. Herman S. Zahn	6th BG	2 Pumpkins, backup A-bomb 6 Aug, Cameras 9 Aug	Renamed *Dave's Dream* – dropped A-bomb, Bikini 1946. Scrapped 1960
B-29-45-MO	44-86291	*Necessary Evil*	V-91	Capt. Norman W. Ray	6th BG	3 Pumpkins, camera ship, Hiroshima	To China Lake 1956, eventually scrapped
B-29-45-MO	44-86292	*Enola Gay*	V-82	Capt. Robert K. Lewis	6th BG	2 Pumpkins, Hiroshima A-bomb aircraft	To NASM 1946
B-29-50-MO	44-86346	*Spook**	V-94	Capt. Elbert E. Smith	39th BG	**	Scrapped 1946
B-29-50-MO	44-86347	*Laggin' Dragon*	V-95	Capt. Edward M. Costello	39th BG	Weather recon 9 August	Radar Calibration. Scrapped 1960

* named after atomic missions ** In USA on supply mission when war ended

Above: Despite wearing four 'Fat Man' symbols, Ralph Devore's* Next Objective *only dropped three 'Pumpkins', including one on the last day of the war. The fourth symbol relates to an aborted 8 August mission when the aircraft returned to Tinian with a live 'Pumpkin' aboard.

Right and above: The 509th Composite Group included two flying units, the 393rd Bombardment Squadron (Very Heavy) and the 320th Troop Carrier Squadron. The C-54Bs of the 320th TCS were based on Tinian from the end of May 1945, supplying the basic needs of the group there until it left in October. Bomb parts were brought to Tinian by B-29 or by ship (specifically the ill-fated USS* Indianapolis*).

Field, Cuba to continue training for long overwater missions. It was routine for them to venture as far north as Norfolk, Virginia entirely over water. The squadron had already received 10 of its required 15 aircraft.

Added to the rigid schedule were visual and radar bombing runs from very high altitudes. During this period there was one significant aspect of normal bomber tactics completely missing: formation flights. Unknown to the aircrews at that time, those missions duplicated the types they would soon fly from Tinian to the Japanese mainland.

Move to Tinian

By March 1945, the final pieces fell into place to raise the 509th to the level of expertise necessary to fulfil its mission. The 1st Ordnance Squadron, Special (Aviation) joined the organisation; it was trained to carry out the technical aspects of the group's operation and was the official 'guardian' of the bomb. This brought the head count to a total of 1,542 enlisted types and over 200 officers.

To the public, the media and the rest of the AAF, the 509th and its mission did not exist. Only a select few even knew that the atomic bomb existed. On Memorial Day (30 May 1945), under a cloak of secrecy, the small composite group moved quietly from its base in the US to North Field, Tinian. Conditions ranged from moderately poor to crude. Few, if any, plans had been made for the arrival of the 509th, so the unit pitched tents and made do with what they had. A month later, space was made at North Field for the group in an area that had previously been occupied by Navy Sea Bees. The new arrangements gave the support units closer access to the aircraft, producing a more efficient working environment. The area could easily be blocked off for security reasons; such measures were necessary, because this was the combat organisation that would change the course of the war in another five weeks.

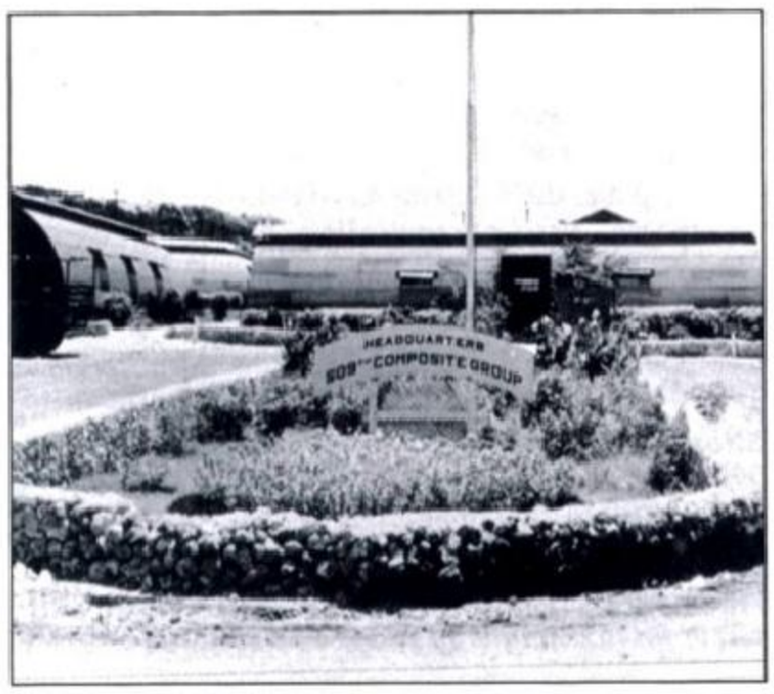
It had been almost 10 months since the US Marines had secured Tinian. Their assault began on 24 July 1944, and eight days later the island was taken. It was just another bloody battle that the Marines fought as they island-hopped towards Japan, leaving in their wake a series of outstanding air bases that opened the way for American air power to destroy the Japanese war machine. Tinian cost the Marines 190 dead, while the enemy death toll soared above 9,000. This victory provided a 48-sq mile (124 km²) island that was only 1,500 miles (2415 km) from Tokyo. It rapidly developed into the biggest air base in the Pacific and a springboard for massive formations of Japan-bound B-29s.

Prime targets

Japan's heavily populated industrial cities were located along a comparatively narrow strip of coastal plain, in the southern part of the main island. Since the Marianas had been captured, the long-range Boeing bombers could easily reach all of those prime targets. Beginning in the final months of 1944, only small numbers of B-29s were used on these missions, but by June 1945 as many as 800 Superfortresses were bombing Japan every day. Japanese civilians were feeling the war for the first time.

The intensity of the practice sorties did not diminish, but they were all undertaken away

Below and right: Within six months of the island's capture, facilities on Tinian had been established to an extent that would not have disgraced a permanent stateside base, but most Tinian-based personnel (including the Manhattan Project scientists) lived in tents. There was some resentment among the other units on the island towards the mysterious newcomers and the resources they commanded.



509th CG B-29s sit on their hardstandings on Tinian. 'Victor 88' in the foreground is Up an' Atom which flew weather reconnaissance over the primary target – Kokura – on 9 August.

Left: Crewmen of the 509th enjoy a day off at one of the basic but popular leisure facilities on Tinian. They included various clubs and a cinema called the 'Punkin Theatre'. Note the macabre decoration beside the enigmatic signboard – a reminder of the battle that had taken place to secure the island for the B-29s.

from the Japanese islands, for security reasons. During the long hours of these missions, the aircrews wondered if they would ever be allowed to fly against targets in Japan. The first of these training sorties were carried out against Rota and Garuan, followed by bomb strikes against key targets on Truk and Marcus Islands. They encountered flak, for the first time, on missions against Marcus. None of these excursions were counted as combat missions because the group was still in training.

Preparing for the big one

Finally, on 20 July, their focus changed. They were ordered to begin bombing targets within Japan. Unknown to the world, and to the 509th, the monumental mission against Hiroshima was only two weeks away. The first targets to experience the group's wrath were Otsu, Taira, Fukushima, Nagaoka, Toyama and Tokyo. The weather was bad over all of the target areas, so the results of the oversized conventional bombs used could not be accurately assessed. These early missions over Japan had a definite purpose: not only would they familiarise the crews with the primary target cities, but they would also accustom the Japanese to the sight of very small numbers of high-flying B-29s overhead without causing undue alarm.

As an extra security precaution, the tail markings on the 509th bombers were constantly changed. The unit's original symbol was a forward-pointing arrow within a large circle. The change would prevent the Japanese becoming suspicious that all of the 'lone' bombers had the same unique tail markings, so tail markings were used from at least four well known Marianas-based Superfortresses groups. They were the 'A' with no border of the 497th BG/73rd Wing, 'N' within a triangle of the 444th BG/314th Wing, the 'P' in a square of the 39th BG /314th Wing, and the 'R' in a circle of the 6th BG/313th Wing.

Twenty-first Bomber Command sent down a series of 'frag orders' which were tentative operational plans, each involving a precision attack against pinpoint targets in the general neighbourhood of – but never within – the cities chosen for the atom bomb attack. These orders resulted in 12 strikes being sent out on four days (20, 24, 26 and 29 July), involving two to six aircraft against each target. The missions were intended to accurately simulate the atomic bomb attack in minute detail: navigational procedure, individual approach at high altitude (usually at 29,000 ft/8840 m), visual release and radical break-away immediately following the bomb release. The weapons dropped on these simulated atomic attacks were known as 'pumpkins' and were light-case 10,000-lb (4535-kg) high-explosive bombs with the same casing and aerodynamic properties as the 'Little Boy' uranium weapon. Special mission symbols were painted on the left side of each aircraft under the pilot's station to record the 'pumpkin' missions: they were profiles of a caricatured 'fat man' in black (participation in the actual atomic missions was denoted by a red figure). The record of the 393rd squadron in delivering these bombs was exceptional. Out of 38 sorties, there was only one abort. Twenty-nine aircraft bombed visually, and eight by radar. The damage actually done by these 'pumpkins' was, strategically, of very little significance, but it proved to all sceptics that the 509th was more than ready for the real thing.

Into their second week of 'practice missions' over Japan, the list of targets grew rapidly to

Shortly after arrival on Tinian, each of the 509th's B-29s was given the group markings of one of four other North Field B-29 groups in order not to alert the Japanese to the existence of a 'special' unit flying solo missions over their cities. After Nagasaki, the official arrowhead and circle fin marking was soon repainted.

include Tsuraga, Niihama, Kobe, Yokkaichi, Shimada, Nagoya, Hamamatsu, Yaizu, Osaka, Uwajima, Kasawazaki, Hitachi, Ube, Wakayana, Maizuru, Koriyama and Tokushima. During this series of missions, only two Japanese fighters were sighted and they kept their distance. AA fire was very light and only one of the bombers suffered light damage. None of the aircrews received a scratch.

The countdown to 6 August continued. In official Army Air Corps records that were released after the war it was revealed that in April 1945 a meteorologist in Washington, DC had made a long-range weather forecast that predicted favourable weather over the primary target for a three-day period. The optimum date was 6 August. This was not a factor in actually determining the date when the Hiroshima mission would take place. Two major considerations would weigh heavily when the time came to make the decision: the availability of the bomb, and the current situation with the Japanese military leadership. In other words, the continued bombing might have brought the enemy closer to surrendering, thereby preventing the invasion.

Development of the atomic bomb

The spark igniting the fire of interest in the atomic bomb within the US government was provided by a letter dated 2 August 1939. It was written by Dr Albert Einstein and addressed to President Roosevelt, and stated that there was a possibility of constructing, from uranium, a bomb of tremendous power. This bomb would be too heavy to be transported by aircraft and would have to be delivered by ship. Over the next 18 months, as more was learned about this nuclear possibility, the potential weight of such a bomb came down to the extent that scientists began talking in terms of it being dropped from an aircraft.

From mid-1941, experimentation with nuclear energy and the atomic bomb had been aggressively pursued by the United States government under the codename of Manhattan Engineer District. Secretary of War Henry Stimson had been directly responsible to President Roosevelt on all aspects of this secret project. Harry S. Truman was not aware of the project until after he became President in April 1945. There had never been any doubt, in Roosevelt's mind, that the bomb would be used when it was ready, and this attitude was immediately adopted by President Truman.

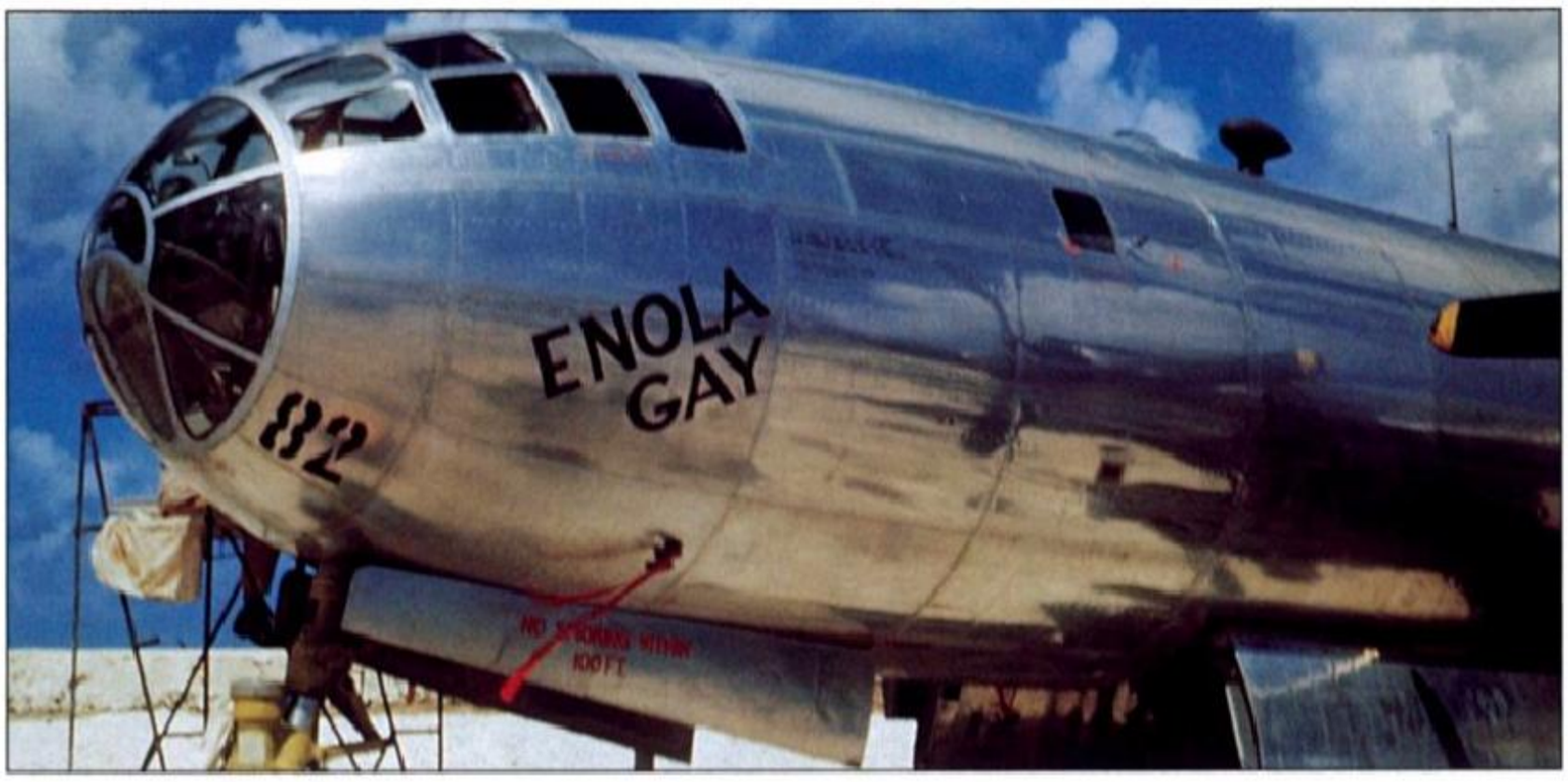
The urgency to end the war was given a tremendous boost when Germany surrendered on 8 May 1945. Immediately after the end of the war in Europe, Secretary Stimson formed a committee of eminent civilians to advise the President on atomic matters. At a 1 June meeting, they recommended three things to President Truman pertaining to the use of the bomb: (1) That the atomic bomb be used against Japan as soon as possible. There was no grey area in this statement, it was brief and to the point. (2) That the bomb be used against a dual target, meaning that it be dropped on a populated area that had important military targets within the 'kill' zone. (3) That absolutely no warning be given to the enemy as to the nature or details of the weapon. There were seven prominent men on this committee and the original vote on these three items was unanimous. Later, one of the members changed his opinion on part three.

Also giving advice to Truman was a large group of scientists who were involved in the development and production of the bomb. They suggested that the bomb not be used until a test demonstration was carried out with all members of the United Nations present. This statement was in the form of a petition signed by 64 scientists. This very unlikely suggestion was neutralised by the scientific panel that had been advising first Roosevelt and then Truman. They saw no alternative to direct military use of the bomb. The panel consisted of four members, of whom J. R. Oppenheimer was the most influential. To say the least, these four had the President's ear. It is believed that their deci-

Above: This is one of the last bombs to fall in World War II. Despite its appearance, it is not the 'Fat Man' atomic weapon, but a bright-orange 9,000-lb (4082-kg) 'Pumpkin' heading towards a munitions plant at Nagoya on 14 August 1945. When Some Punkins – the B-29 that dropped it – returned to Tinian, the war had ended.

Right: This is the loading pit on Tinian in which the atom bombs were prepared for hoisting aboard the B-29s. Originally, the fitting of the fuses was supposed to take place here, but on 6 August Enola Gay's 'weaponeer' William Parsons, fearful of the consequences of a take-off crash, armed the bomb in flight.

Right: Some Punkins was flown by Captain James Price on five 'Pumpkin' missions over Japan, including one on the last day of the war – five days after the Nagasaki attack. The 509th also flew practice missions against the Japanese-held island of Rota in the Marianas.



Above: Colonel Paul W. Tibbets (with pipe) poses with* Enola Gay *and its ground crew in the final hours before the Hiroshima mission. Few men of the 509th were let into the atomic secret and even the enlisted men on the* Enola Gay*'s crew were not informed of the nature of the weapon they were carrying until they were nearly two hours away from Tinian, on the way to Japan.

Above: The B-29 that was to become the most famous warplane in history was chosen personally by group CO Paul Tibbets from the Martin factory in Omaha. The aircraft was collected by and assigned to Captain Bob Lewis and crew. Lewis found out that he would not be commanding the first atomic mission only a few days before 6 August. Tibbets named the bomber after his own mother hours before take-off.

sion was based on the possibility of the demonstration bomb being a 'dud', making its use (in the presence of UN personnel) a very bad psychological risk.

Under the tightest security, the final details were being determined with two of the top military 'heads' present: General H. H. Arnold and Major General Curtis LeMay. They began with the second suggestion made by the civilian committee. Arnold had already selected some targets with major war plants or military installations surrounded by or adjacent to large areas of civilian housing. After further discussion, it was decided that a target should be selected which had been relatively untouched, because this would have the largest psychological and experimental results. With this suggestion, six of the targets that were on the 'hit' list had to be removed.

General Arnold stated that Kyoto was the largest city in Japan that had not been bombed. The other three cities on this list, in order of total population, were Hiroshima, Niigata and Kokura. General LeMay was ordered to reserve these cities for the 509th. A short time later, Stimson convinced Arnold to take Kyoto off the list. The argument put by Stimson was that it had great significance to the Japanese people as a national shrine of religion and culture. It was removed by Arnold with great reluctance. One can guess which city was added to the list to replace Kyoto – Nagasaki. The latter city remained at the bottom of the list because it was not considered a perfect target, due to its topography. Once resolved, the four cities on the list became the focus of attention of a large group of intelligence officers at the Pentagon and in the Marianas.

The final details for both of the missions were worked out on Tinian. The two teams involved in the last-minute preparations included Project Alberta (Project A) and key planners from the 509th. The Project A people had been organised in March, as a separate element of the Manhattan Project at Los Alamos. Their sole purpose was to unify the various activities concerned with the preparation and combat use of the atomic bombs. Their three main priorities were: (1) Design, procurement and preliminary assembly of the bombs, so that they were complete and ready for use with active materials in place. (2) Continuation of the Wendover (weapon shape) test programme. (3) Preparation for overseas operations against Japanese targets.

Three of the notable 'Silverplate' B-29s of the 509th CG, all of which had a role in the Hiroshima mission, were* Full House *flown by Major Ralph Taylor, Major Claude Eatherley's* Straight Flush*, and Captain George Marquadt's* Necessary Evil*.* Full House *flew the greatest number of 'Pumpkin' missions (six) and flew weather reconnaissance over the secondary target (Nagasaki) on the Hiroshima raid. Eatherley was the maverick of the 509th and had attempted to hit the Emperor's palace with a 'Pumpkin' on an earlier raid on Tokyo. On 6 August he flew weather reconnaissance over Hiroshima and sent back the "Advice: bomb primary" signal to Tibbets in* Enola Gay*.* Necessary Evil *(also known as* No. 91*) was assigned the high-speed photography platform for Hiroshima, although a technical fault resulted in a failure to record any usable film. Red 'Fat Man' symbols denoted atomic missions.

Backup ships

Considering the scope of the project, the groups worked very well together, and both missions included their joint participation onboard the aircraft. On the Hiroshima and Nagasaki missions, *Great Artiste* (44-27353/V-89) was the principal instrument ship accompanying the bomb-carrying B-29s. On each flight, three members of Project A were onboard to operate and monitor the instruments.

A third B-29 was sent with the strike force, equipped with a special high-speed camera

(called Fastax). This camera was brought from Los Alamos to record the initial explosion and growth of the fireball. On the Hiroshima mission *Necessary Evil* (44-86291/V-91) was the camera ship, and when the Nagasaki drop took place three days later *Big Stink* (44-27354/V-90) carried the cameras.

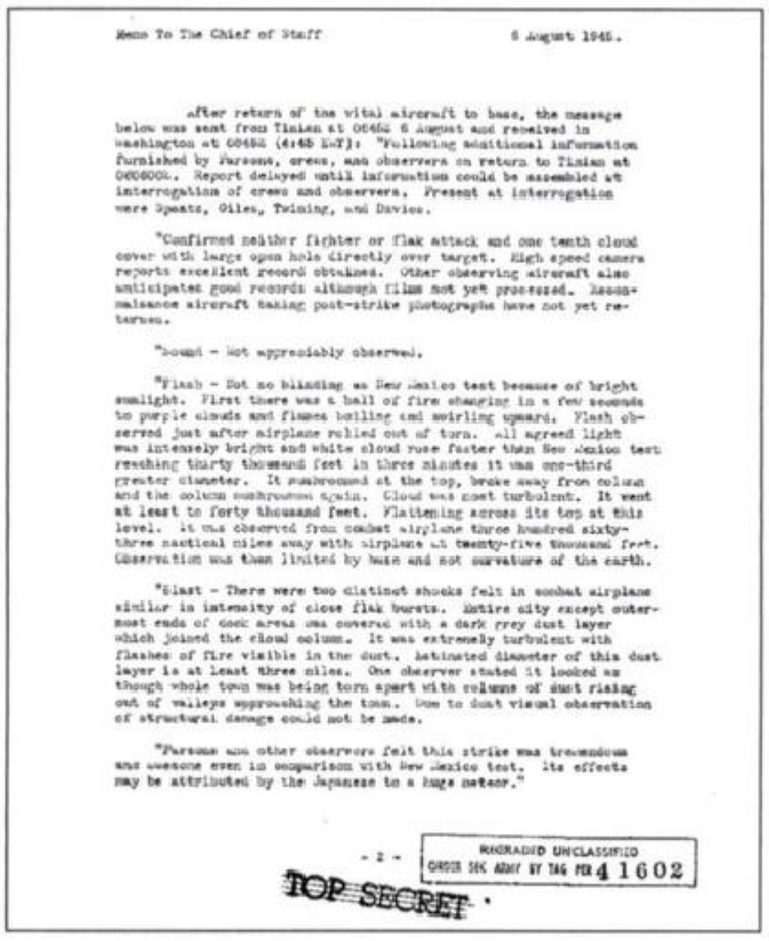
Theoretical effect

The following data on the projected atomic explosion was passed on in the form of a memorandum sent to General Spaatz on Tinian, from J. R. Oppenheimer. "It is expected that radioactive contamination will reach the ground. The ball of fire should have a brilliance which should last longer than the one at Alamogordo, since there will be very little, if any, dust mixed with it. In general, the visible light emitted by the unit should be even more spectacular. Lethal radiation will, of course, reach the ground from the bomb itself."

Following the stunning Alamogordo explosion, Oppenheimer had calculated that release from the first bomb to be dropped on Japan would be in the region of 12,000 to 20,000 tons of TNT. By comparison, it would have taken about 2,000 B-29s, carrying full bomb loads, to have generated that much destructive power. For the few people that knew all of the details, it was hard to imagine the destruction that was about to be unleashed on Japan.

If the first or second bomb drew no reaction from the Japanese military, the issue remained of the extent to which the atomic bombing would continue before Japan surrendered. Major General Leslie Groves, who was in charge of developing and producing the atomic bomb, wrote a memo dated 30 July to the Chief of Staff. In it he outlined a sinister schedule that would answer any questions as to how far the United States would be capable of going to end the war. "In September we should be able to have three to four bombs ready, and the same number would follow in October. In November the number would increase to five, and finally seven by December. The production will increase accordingly into 1946."

On the afternoon of 2 August, Colonel Tibbets and his bombardier, Major Tom Ferebee, arrived on Guam at LeMay's



Memo To The Chief of Staff 6 August 1945.

After return of the vital aircraft to base, the message below was sent from Tinian at 0645Z 6 August and received in Washington at 0845Z (4:45 EsT): "Following additional information furnished by Parsons, crews, mas observers on return to Tinian at 0600CK. Report delayed until information could be assembled at interrogation of crews and observers. Present at interrogation were Spaatz, Giles, Twining, and Davies.

"Confirmed neither fighter or flak attack and one tenth cloud cover with large open hole directly over target. High speed camera reports excellent record obtained. Other observing aircraft also anticipates good records although films not yet processed. Reconnaissance aircraft taking post-strike photographs have not yet returned.

"Sound - Not appreciably observed.

"Flash - Not so blinding as New Mexico test because of bright sunlight. First there was a ball of fire changing in a few seconds to purple clouds and flames boiling and swirling upward. Flash observed just after airplane rolled out of turn. All agreed light was intensely bright and white cloud rose faster than New Mexico test reaching thirty thousand feet in three minutes it was one-third greater diameter. It mushroomed at the top, broke away from column and the column mushroomed again. Cloud was most turbulent. It went at least to forty thousand feet. Flattening agross its top at this level. It was observed from combat airplane three hundred sixty-three nautical miles away with airplane at twenty-five thousand feet. Observation was then limited by haze and not curvature of the earth.

"Blast - There were two distinct shocks felt in combat airplane similar in intensity of close flak bursts. Entire city except outermost ends of dock areas was covered with a dark grey dust layer which joined the cloud column. It was extremely turbulent with flashes of fire visible in the dust. Estimated diameter of this dust layer is at least three miles. One observer stated it looked as though whole town was being torn apart with columns of dust rising out of valleys approaching the town. Due to dust visual observation of structural damage could not be made.

"Parsons and other observers felt this strike was tremendous and awesome even in comparison with New Mexico test. Its effects may be attributed by the Japanese to a huge meteor."

- 2 -

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TOP SECRET

The report of the Hiroshima mission crews was wired to Washington as soon as the debreifing was over. 'Parsons' was Captain William Parsons USN, who had been with the Manhattan Project almost from its beginning.

The U-235 bomb that fell on Hiroshima killed 80,000 people immediately or in the days that followed. Many more were to die in the coming months and years from the lingering – and then little-understood – effects of radiation.

headquarters to complete the details for the 6 August mission. The first question out of Tibbets's mouth regarded the identity of the target city. Without hesitation, LeMay answered that he preferred Hiroshima. He knew it contained a large number of troops and war factories. They moved over to the large map table that contained all of the latest reconnaissance photographs of the primary target. LeMay asked Ferebee to show him what aiming point (AP) he had selected and the bombardier placed a finger on the 'T'-shaped Aioi Bridge in the centre of Hiroshima. It was the perfect AP.

Eve of destruction

The night of 5/6 August held very little sleep for crew members of the *Enola Gay* or, for that matter, anyone within the confines of the 509th group area. Colonel Tibbets began his day by holding a meeting with the aircrews that would accompany his B-29 to Hiroshima. Everyone knew that this was the mission for which they had been trained. There was still no mention of any atomic or nuclear device, only a statement from Tibbets that they should be sure to wear their heavily tinted goggles prior to the explosion.

Both *Great Artiste* and *Necessary Evil* would accompany *Enola Gay* over Hiroshima. The two former bombers topped out at 7,400 US gal (28000 litres) of fuel, but *Enola Gay* carried only 7,000 US (26500 litres). This was to compensate for the excess weight of the bomb and to keep the aircraft at an optimum weight to ensure it could get airborne.

Take-off for Hiroshima

At 01.37, three weather reconnaissance B-29s launched from separate runways at North Field. *Straight Flush*'s destination was Hiroshima, *Jabitt III* would cover Kokura, and *Full House* would be over Nagasaki. Weather reports from these three aircraft would determine the final target for Tibbet's aircraft. Fourteen minutes later, *Big Stink* took off for Iwo Jima, where it would be *Enola Gay*'s backup.

As Colonel Tibbets and his crew arrived on the flight line, his aircraft was completely illuminated by floodlights that enabled film crews to record every detail of V-82's departure, a mob scene resembling media events of

Informed of the successful strike on Hiroshima, hundreds of men waited to give* Enola Gay *a rapturous reception upon its return after a flight that totalled 12 hours and 13 minutes. Tibbets was awarded the DSC on the spot by General Spaatz, and the crew was led away for debriefing.

***Men of the 509th gather around* Enola Gay *on its return from Hiroshima.* Full House *(in the markings of the 39th BG) is in the background. The 509th's mess officer began to prepare for Tinian's biggest party when the 'strike successful' message was wired from* Enola Gay.

The second atomic mission, to Nagasaki, also involved a number of B-29s flying in a supporting role to the bomb-carrying aircraft.* Up an' Atom *flew on 'Pumpkin' operations with three different crews but was assigned to Captain George Marquadt who flew weather reconnaissance over Kokura on 9 August. The name seems to have been applied before the atomic missions, which may with hindsight seem a gross breach of security, but it should be noted that few people at that time knew of atomic energy or its potential use in a weapon. The covering on the girl, however, did not escape the censors and was changed from a diaphanous affair to the black number seen here.* Big Stink *was involved in both missions, acting as backup to* Enola Gay *(but remaining on Tinian) and performing high-speed photography over Nagasaki, although it failed to make the rendezvous with* Bockscar. *The only combat mission of Captain Charles McKnight's* Laggin' Dragon *was the vital reconnaissance over Nagasaki on 9 August.

the present day. After much fanfare and a final check of the aircraft, the bomber started its engines at 02.27. Eight minutes later, *Enola Gay* was in take-off position. Its weight was recorded at 150,000 lb (68040 kg), which included the 7000 US gal (26500 litres) of fuel, a 10,000-lb (4535-kg) bomb and the 12 men on board. Compared to normal missions, it was overloaded by 15,000 lb (6800 kg).

Two minutes after the bomb ship lifted off, the two escort bombers launched. All three aircraft would join up over Iwo Jima, in three hours, for the long flight to their target in Japan. After reaching an altitude of approximately 5,000 ft (1525 m), 15 minutes into the flight, the two bomb specialists moved into the bomb bay area to begin the process of arming the nuclear device that had been named 'Little Boy'. Officially, they began at 03.00, and the job was finished at 03.20.

The three aircraft joined up over Iwo Jima just before 05.00 Japanese time. The two escorts had been trailing about 3 miles (5 km) behind *Enola Gay* for most of the flight. They slowly climbed to 9,000 ft (2745 m) in a gentle orbit. Five minutes later, the lead navigator, Captain Theodore Van Kirk, set the course for Shikoku, an island off the southeast coast of Japan. They formed a loose 'V' formation with Tibbet's bomber in the lead. This was the day that they had all trained for and it would make the history books for generations to come.

According to records available to James L. Cate, the chief of Historical Records of the 20th Air Force in 1945, Tibbets was to select the target based on weather reports he received from the 509th aircraft over the three cities that had been chosen. If all three were covered with clouds, he was to bring the bomb back to Tinian. At 08.15 Tibbets received a report from *Straight Flush*: "2/10 lower and middle and 2/10 at 15,000 ft." This locked up Hiroshima as the target and there was no need for data from the other two B-29s that were orbiting Nagasaki and Kokura.

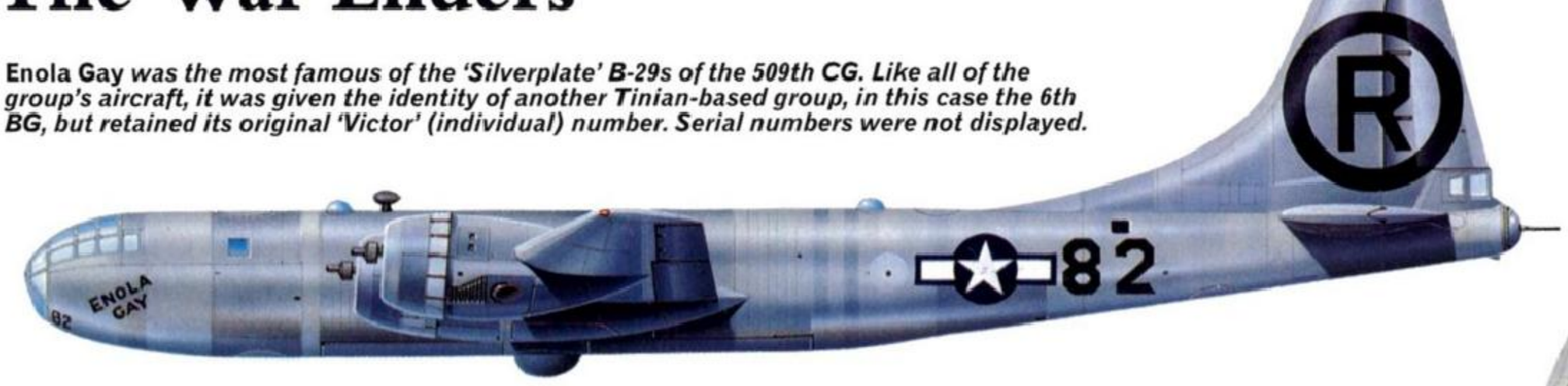
Bomb away

At precisely 08.15, Major Thomas Ferebee pushed the switch that rapidly opened the bomb bay doors and toggled the bomb out. The recorded altitude was 31,600 ft (9630 m) and ground speed was 328 mph (527 km/h). Immediately after the bomb cleared the aircraft, Colonel Tibbets took over the controls and executed a violent 155° turn away from the AP, dropping the nose to gain as much airspeed as possible.

'Little Boy' was timed to explode 1,890 ft (576 m) above the ground. Forty-three seconds after leaving the *Enola Gay*, the bomb detonated 800 ft (244 m) away from its aiming point of the Aioi Bridge. At that moment, all three of the 509th aircraft were 15 miles (24 km) from the blast. What they saw next was something that will never be forgotten: an enormous, instantaneous fireball engulfing the area. It was followed by a phenomenon that only the tail gunner, Technical Sergeant George Caron, could see. A visible mass of air was rushing up and away from the blast, a shock wave that was moving at a much greater speed than the B-29s. He shouted for everyone to brace and the first wave hit, throwing around the *Enola Gay* like a toy. Four seconds later, another shock wave hit them with about the same intensity. Tibbets fought to bring the

The War Enders

***Enola Gay* was the most famous of the 'Silverplate' B-29s of the 509th CG. Like all of the group's aircraft, it was given the identity of another Tinian-based group, in this case the 6th BG, but retained its original 'Victor' (individual) number. Serial numbers were not displayed.**



The spurious markings on* Bockscar *were those of the 444th BG, and included that unit's red fuselage band. Stripped of armament except for tail guns, the only disruption to the clean lines of the 'Silverplate' B-29s was the underfuselage AN/APQ-13 radar dome.

In the pre-dawn darkness of 9 August 1945, the crew of **Bockscar** *review the route to Kokura and the alternate targets. From left to right are navigator James Van Pelt, pilot Charles Sweeney and observer Fred Olivi.*

Final preparations complete, Major Sweeney (left) accepts the good wishes of Colonel Tibbets. The mission of **Bockscar**, *already plagued by an unserviceable fuel tank, was not to be nearly as smooth as the first atomic strike.*

aircraft back on an even keel and, in seconds, they were back in calm air.

Colonel Tibbets set up an orbit above Hiroshima at 29,200 ft (8900 m) and 11 miles (18 km) from the detonation. The fireball continued to expand, and at the core of the blast the temperature probably hit 50 million °C (90 million °F). Almost everything combustible in this area was vapourised. It was by far the most destructive explosion that any human had ever witnessed. After three orbits of the target area, Tibbets headed for Tinian with the other two B-29s trailing close behind. The mushroom cloud that had been so visible did not fade from view until the aircraft were over 360 miles (580 km) from Hiroshima.

The celebration that followed the return of *Enola Gay* has been publicised many times over the past 50 years. Over 200 officers and men surrounded the aircraft when it came to a halt on Tinian, with several thousand more lined along both sides of the runway. For a brief moment, after the crew had descended from the aircraft, the crowd was moved back to make room for General Spaatz, who was there to congratulate and pin the Distinguished Service Cross on Colonel Tibbets. Although lacking in sleep, the crew enjoyed the party and appreciated the significance of their mission.

Rain of ruin

News of the successful mission was flashed to President Truman, who was onboard the *Augusta* returning from the Potsdam Conference. The news was released to the public 16 hours after the detonation. The message from Truman stated that if the Japanese leaders did not surrender, then they would receive a "rain of ruin from the air, the like of which has never been seen on this earth." Japanese military officials tried to downplay the significance of what had happened at Hiroshima. The Japanese Press merely stated that a new type of bomb had been dropped by parachute on Hiroshima, causing considerable damage, and that they should not be taken lightly. Intelligence reports conclude that the mention of 'parachutes' indicated that those people who had observed the blast spotted the parachutes attached to instruments that had been released from the instrument ship to record the intensity of the explosion.

On 1 August there had been enough fissionable material for only two bombs. The strategy was to use both bombs at close intervals, assuming that the first did not end the war. Another fact that surfaced soon after the war's end was that 11 August had been the planned date for the second mission. When the weather reports were projected to that date it became apparent that, due to bad weather, the date had to be advanced to 9 August.

The endless B-29 bomber streams that headed to Japan every day did not let up. On the day following the Hiroshima attack, a 131-aircraft daylight incendiary strike was ordered against Tokokawa. On 8 August more strikes were flown, including six of the 509th's 'Silverplates' flying 'pumpkin' missions against select targets in Japan. Still there was no indication from Japanese authorities that the end might be near.

Planning for the second mission reached its final stages. The bomb named 'Fat Man' would be carried by *Bockscar*, the aircraft normally assigned to Captain Fred Bock, but the pilot for the mission would be 393rd squadron commander, Major Charles Sweeney. This time, only two weather aircraft would be launched. First choice was Kokura, a city near the northern tip of Kyushu. Nagasaki, on the western coast of Kyushu, was the secondary target. The third city was to have been Niigata, but it was ruled out because of the longer distance from Tinian. Both Kokura and Nagasaki housed vital military installations. Nagasaki's topography, broken by hills and valleys, and its irregular layout made it a very unfavourable target from a military and experimental point of view.

The mission that delivered the second and final atomic bomb got underway on 9 August at 02.30 when the two weather aircraft took off from Tinian. One hour and 19 minutes later, the strike force followed. The course towards Japan deviated somewhat from that of the first mission because of a sizeable storm front converging on Iwo Jima.

Secondary target

Bockscar arrived at the rendezvous point over Yakujima on the south coast of Kyushu at about 09.09, one minute ahead of schedule. The aircraft waited in the area for the camera ship, but after 45 minutes Major Sweeney led the two B-29s towards Kokura. Unfortunate circumstances dogged them on the entire mission. Kokura was socked in by weather conditions that would not allow a visual drop, which proved to be an unusual situation. The city adjacent to Kokura was Yawata, which had been the subject of massive nocturnal fire bomb raids two nights previously, and it was still burning. The wind patterns at the time of the second atomic bomb mission carried heavy smoke and debris from Yawata over Kokura.

Above:* Bockscar *was the aircraft assigned to Major Fred Bock and crew, and after the Nagasaki strike it received its familiar nose art. On the actual mission, it was flown by 393rd BS CO Major Sweeney, which led to some post-war confusion as to which aircraft dropped the Nagasaki bomb.

Above:* The Great Artiste *was named for Major Sweeney's bombardier Kermit Beahan, who was known as the most accurate bombardier in the 509th. The aircraft flew on both missions as the instrumentation ship. Sweeney 'borrowed'* Bockscar *on 9 August rather than remove all the specialised equipment from his 'own' B-29.

Above: The more powerful 'Fat Man' bomb caused fewer fatalities and less destruction than 'Little Boy' due to the geography of the target. Nevertheless, 50,000 citizens of Nagasaki were killed, or died soon after it was dropped, and two-thirds of the city was destroyed.

Above: US Navy personnel are seen viewing the devastation at Hiroshima. After the Japanese surrender, many parties from the allied forces visited the two cities destroyed by the bombs, including a group from the 509th led by Tibbets.

Above: In 1949, when this picture was taken, Hiroshima was only beginning to recover from the effects of the atomic bomb. The Prefectural Building for the Promotion of Industry, seen here, which was near the epicentre of the explosion, has been preserved as a peace memorial.

After returning to the US in October 1945, **Enola Gay** *(left) participated in Operation Crossroads with the 509th (by then a bomb wing). After a period of storage at various locations – including at Tucson as seen here in 1946 – it was delivered to the National Air and Space Museum for which it was stored at Andrews AFB until 1965.* **Enola Gay**'s *fuselage was displayed during 1995/96 as part of a controversial exhibit to mark the 50th anniversary of the atomic missions.* **Bockscar** *was also involved in Crossroads but nearly did not survive to be preserved. Until 1955, the official story was that* **The Great Artiste** *dropped the Nagasaki bomb and it was only after Fred Bock's father lobbied the Air Force with documentary evidence of the true facts that* **Bockscar** *was slated for preservation at the US Air Force Museum. The lower view shows the aircraft after arrival at Wright-Patterson AFB in 1961. The Victor number and tail symbol are, mysteriously, those of* **The Great Artiste.**

This made it impossible to draw a visual on the AP for the 'Fat Man' drop. With fuel running low (600 US gal/2270 litres of fuel trapped in the bomb bay tank would not feed), Sweeney made the decision to hit the secondary target of Nagasaki. This meant that *Bockscar* would have to refuel at Okinawa on the way back to Tinian.

The weather over Nagasaki was not much better. It was 8/10 cloud and the 'run-in' was 90 per cent by radar. At the last minute, bombardier Captain Kermit Beahan found a hole in the clouds and let the bomb go. It was exactly 10:58 Japanese time. Major Sweeney banked his aircraft sharply, pushing the nose down from the 28,900-ft (8810-m) altitude. When the shock wave from the bomb hit the bomber, it was described "like a telephone pole beating us." The turbulence evidently was much worse than that encountered over Hiroshima.

Critical situation

For various reasons, including the non-rendezvous of the photo aircraft on the Nagasaki mission, the special cameras were not able to record either atomic mission. The majority of pictures taken of the bomb explosions were taken by crew members with their own or borrowed Press cameras. These 'amateur' photos have been published numerous times over the past 50 years.

The fuel situation on *Bockscar* became critical. A message sent to Tinian was apparently never received. Sweeney headed for the closest base, which was Okinawa, where he landed at 14:00 with only a few gallons of fuel remaining. After taking on enough for the flight back to Tinian, Sweeney took off and was on the ground there at 23.39. This mission proved to be the one that initiated the surrender of Japan.

There was no word from the Japanese immediately following the Nagasaki mission. The 509th had several 'pumpkin' missions planned, which they executed. The final missions were flown on 14 August 1945. Captain James N. Price, aircraft commander on *Some Punkins*, remembers what was probably the final bombing mission of the war: "We started briefings in the late afternoon of 13 August. We had hopes that this would be the final mission over Japan. There were specialised briefings for the bombardier, navigator and other crew members. After a short break, we returned for the main briefing for all crew members, checked out our equipment and then went to the flight line. The load for this mission was 7,200 lb of fuel and one 10,000-lb 'pumpkin' bomb. Our only armament was two 0.50-in machine-guns mounted in the tail turret.

"With clearance from the tower, we pulled up to the main runway and began our take-off roll. After a short climb, we levelled out at 8,000 ft. Over Iwo Jima, we altered our course to put us in direct line with the target, which was the Nagoya Munitions Arsenal. This is a distance of 1,500 miles from Tinian, which would be like a bomb mission from Mexico to Canada. Along the route, we were to monitor and record weather conditions every hour. This data was given to the operations officer when we returned.

The last bomb

"There were two other 393rd aircraft on this mission and they were ahead of us due to problems we were having with the automatic propeller speed controls. Keeping the props synchronised was very difficult. Our bombardier, Lieutenant Tom Costa, was worried that this would prevent us keeping a constant ground speed during our bomb run. That was a critical period, when he was constantly adjusting his bomb sight for speed and drift caused by crosswinds.

"When that much weight (the bomb) left the aircraft quickly, it caused an unbalanced force on the plane, which tended to pitch up unless corrections were made at once. As the bomb departed the bomb bay, we were able to take some pictures. The closest one shows a smiley face with signatures from numerous 509th personnel. While we were in our bomb run, Lieutenant Costa noticed several flashes in his bomb sight, of Japanese fighters taking off from a nearby airfield. They got airborne, but didn't bother us.

"We were told that if the war ended while we were en route to Nagoya we were to turn around and drop the bomb in the ocean. I can't recall whether we received the message [that the war had in fact ended] while we were en route back to Tinian or after we landed. Twenty-four hours had elapsed since the time we began the first briefings and the time we touched down."

Once the war ended, the 509th remained on Tinian for several weeks. Finally, in November 1945, they moved all aircraft, personnel and equipment to their new permanent base at Roswell AAF, New Mexico. They all knew that they had delivered the devastating weapon that had ended the war and had contributed heavily to preventing the bloody and costly invasion of Japan.

Warren E. Thompson

509th Bomb Wing 1945-1997

The first post-war base for the 509th was Roswell Army Airfield (later AFB), New Mexico, where the group's aircraft are seen in February 1948, the year following the alleged UFO crash known as the 'Roswell Incident'. The wing and squadron badges were approved in 1952.

After the atomic missions, the 509th remained on Tinian until October 1945 when it began to move back to the United States. The group was based at Roswell AAF, New Mexico. Post-war budget cuts led to a decline in morale and efficiency until a new structure was created to handle the new nuclear capability of the Army Air Forces. Strategic Air Command was formed on 21 March 1946, and its assets included the 509th CG, which was redesignated the 509th Bombardment Group (Very Heavy) in July. In that month, the 509th was sent to Kwajalein in the Marshall Islands where it took part in Operation Crossroads, the first post-war nuclear test, dropping one A-bomb (Test Able) and monitoring the effects of a second, underwater, detonation (Test Baker).

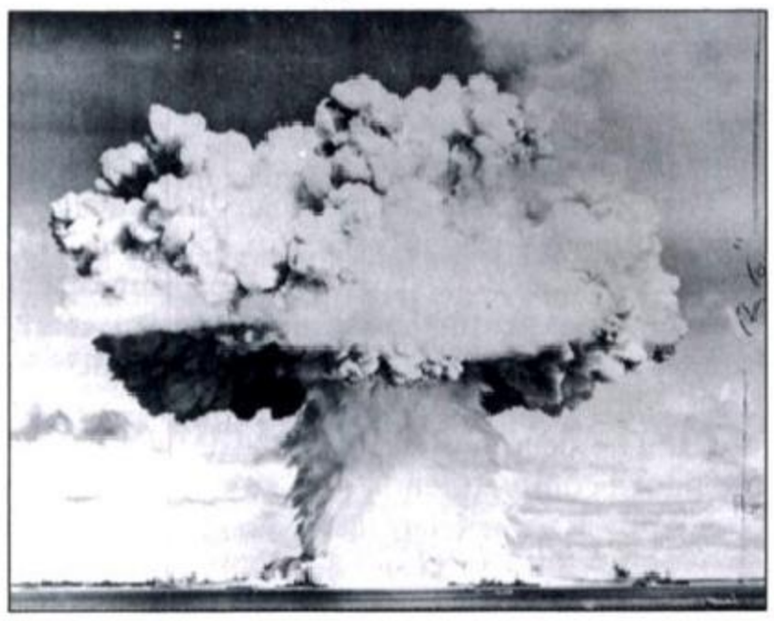
SAC activated the 509th Bomb Wing on 17 November 1947 and brought the 509th BG under the wing's control, adding the 715th and 830th Bomb Squadrons to its roster. In July 1948, the group was redesignated as the 509th BG (Medium) and adopted an air refuelling tasking with B-29M and B/KB-29P tankers, in addition to bombardment. The dedicated air tanking unit, one of the first two such units in the Air Force, was designated the 509th Refueling Squadron.The B-29 bombers were replaced by B-50s in 1949-50, but the 509th's direct association with the Superfortress continued until the KB-29M tankers were replaced by the KC-97 in January 1954.

Less than five years after activation the Air Force deactivated the 509th group and transferred its lineage and traditions to the 509th Bomb Wing. In 1955, the wing fully entered the jet age with the adoption of the all-jet B-47 Stratojet. In August 1958 the wing moved from Roswell (now Walker AFB) to Pease AFB, New Hampshire, where it was to remain, with occasional rotations to Europe and the Far East, for the next 30 years. As the B-47 was being phased out of the SAC inventory in 1965, the 509th briefly faced disbandment, but was reprieved and began to receive B-52s and KC-135 tankers in March 1966. At this time the 830th BS was deactivated.

The 509th participated in its second war – thankfully, in a conventional role only – in Vietnam when it was deployed to Anderson AFB, Guam to fly Arc Light bombing missions in April 1968. This first six-month tour was followed in April 1969 by another, at the end of which the 509th received word that it would convert to the new FB-111, which it did from December 1970. The 509th's two squadrons – the 393rd 'Tigers' and 715th 'Eagles' – began a two-decade period on nuclear alert status in July 1971. Full operational status with the FB-111 was declared in January 1973.

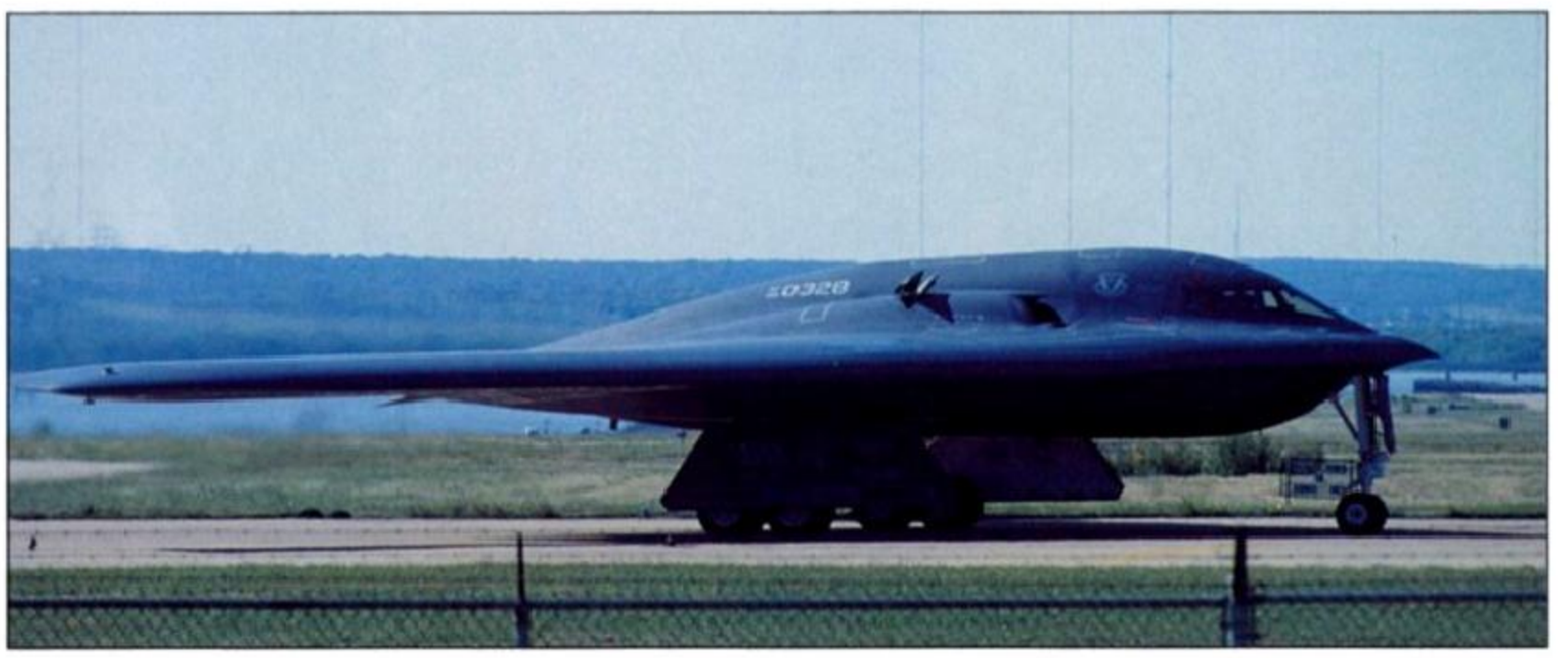
The closure of Pease was announced in 1988, and the threat of deactivation loomed again until it was decided that the 509th would be the first (and probably the only) bomb wing to fly the hugely expensive B-2 'Stealth Bomber'. In September 1990, the 509th made a 'paper move' (without personnel or equipment) to Whiteman AFB, Missouri. On 17 December 1993,the 49th anniversary of the activation of the original 509th CG, the 393rd BS took delivery of its first B-2. Today, a second 509th squadron (715th BS) is well on the way to being equipped with the B-2A Spirit.

Above and below: Post-war,* Big Stink *was named* Dave's Dream *and dropped the first atomic bomb ('Able') at Bikini Atoll, on 1 July 1946.* Dave's Dream *replaced* Enola Gay, *which was grounded by a mechanical failure. In the surface 'Baker' test (below), the 509th had photographic, data measurement and support roles.



Right: The 509th operated FB-111As for 20 years from Pease, with deployments to the UK (top). In 1990, on the eve of the unit's disposal of the 'Aardvark', a number of aircraft wore 'nose-gear door art' commemorating the 'Silverplate' B-29s.

Below: The B-2A now in service has neither fin nor much of a 'fuselage', so most of the identification markings are presented on the huge main gear doors.

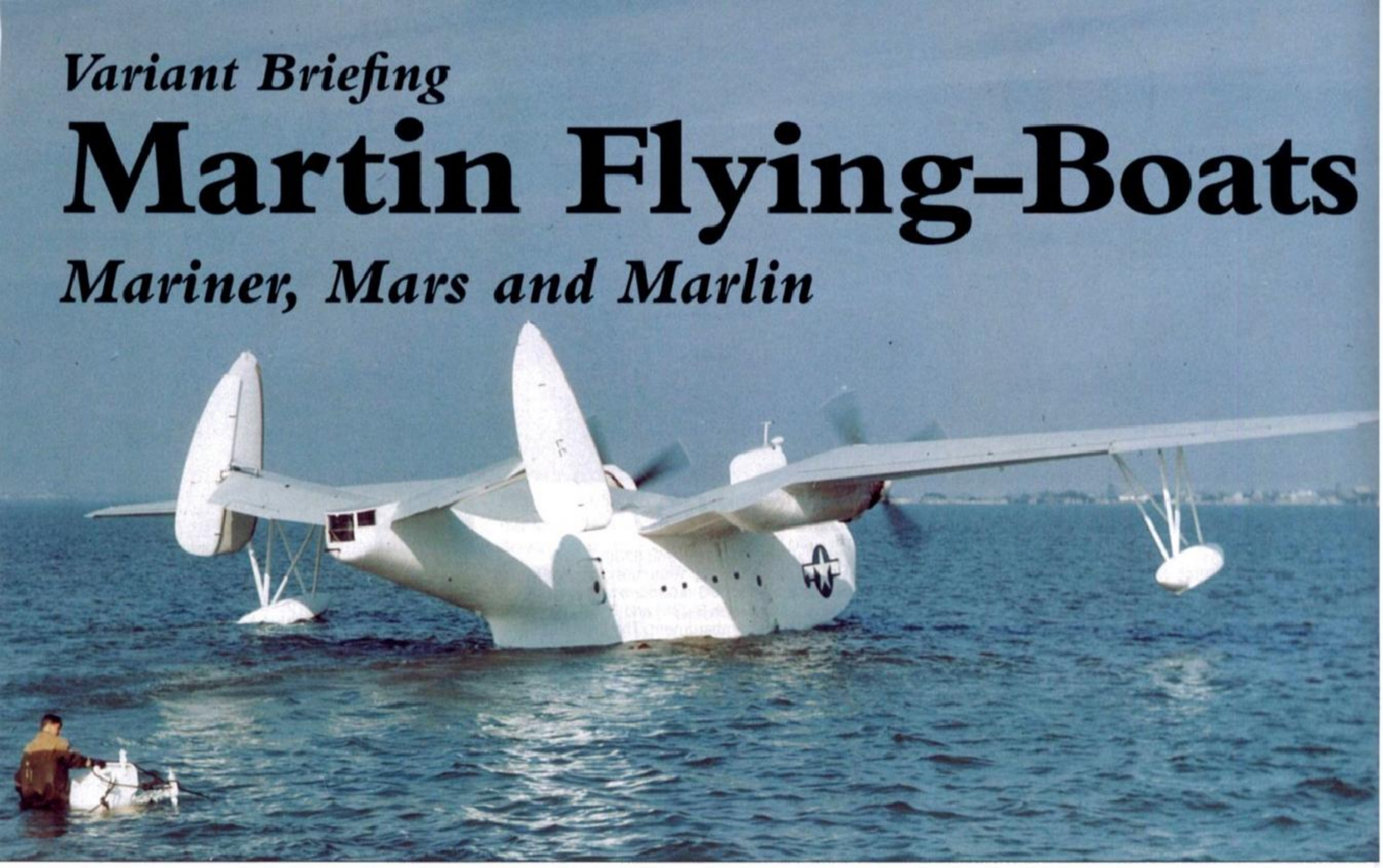


Below: The 509th BW's B-47s were frequent visitors to Europe in the 1950s and early 1960s, often as part of 90-day Reflex Action deployments. This B-47E is seen at Upper Heyford carrying a Tee Town ECM pod.

Variant Briefing

Martin Flying-Boats

Mariner, Mars and Marlin



When it ordered the Martin PBM Mariner into production in 1937, the US Navy hedged its bet with a split purchase of 21 PBM Mariners from Martin and 33 PBY-4 Catalinas from Consolidated. In the end, the robust, versatile PBM Mariner needed no insurance policy. The aircraft made a vital contribution to World War II, the early Cold War, and the Korean fighting. Its builder, the Glenn L. Martin Company of Baltimore, Maryland, arguably became the most experienced manufacturer of seaplanes in the world. Yet the Mariner was always the second best-known American flying-boat. Built in fewer numbers, the Mariner was 20 per cent more expensive, more heavily armed, and faster – but was ever in the shadow of its lumbering rival, the Catalina.

Martin's PBM was produced in a variety of specialised sub-variants – the -3R transport, the -3 and -5E 'electronic', and the -5G Coast Guard Mariners among them. The 'S' suffix stood for anti-submarine duties, as carried out by this PBM-3S in a gull grey and white anti-sub scheme being launched at NAS Norfolk in 1944.

Martin developed the Mariner (Model 162) in part as a replacement for its open-cockpit P3M flying-boat which served the US Navy as patrol aircraft from 1931 and in part in an ambitious hope of eclipsing the Catalina. The manufacturer built and tested a single-seat, three-quarter scale model, the 162A, to evaluate the future PBM's handling in the air and at sea. On 30 June 1937, the US Navy signed up for a full-sized developmental prototype and the XPBM-1 flew on 18 February 1939. Martin turned out Mariners in two principal variants (PBM-3 and PBM-5) and a dozen sub-variants

Those pre-war years were a time when flying-boat technology made great strides forward. In 1935, the most numerous US Navy flying-boat was the Naval Aircraft Factory PN-12 (also manufactured by Martin as the PM), with a gross weight of 14,122 lb (6405 kg), a maximum speed of 114 mph (183 km/h), and token armament of two hand-held 0.30-in (7.62-mm) machine-guns. The P3M and the Catalina improved significantly on these figures, yet were creations more of the past than of the future. It remained for the Mariner to achieve a real breakthrough. The prototype XPBM-1 weighed nearly 60,000 lb (27215 kg) and nudged 200 mph (321 km/h).

Mariner described

The Mariner was costlier than the Catalina, but it offered great increases in capability. In contrast to the PBY's parasol wing supported by high-drag struts, the Mariner's wings were cantilevered from its deep hull; their distinctive 'gull' shape raised the engines clear of the water. The deep hull was double-decked under the pilot's compartment.

All production Mariners were powered by Wright R-2800 Cyclone 14-cylinder double-row air-cooled piston engines. Like the aircraft, the powerplants were improved as production continued. The engines were mounted in large nacelles which included weapons bays to accommodate a combined total of up to 2,000 lb (907 kg) of bombs or depth charges. The fuel system of the Mariner was especially versatile: it

The Mariner entered service in the last year of peace with the delivery of 13 PBM-1s to VP-55 (redesignated VP-74 in 1941) and six to VP-56 (later Transitional Training Squadron Atlantic). PBM-1s such as this VP-56 aircraft were among the last flying-boats to receive the colourful pre-war markings.

Mariners were used by VR-2 on troop and materiel transport duties along the old Pan American routes. This PBM-3R is seen leaving San Diego at the start of another long transpacific journey, circa May 1943.

was possible to draw fuel from almost any combination of tanks with any combination of engines. The full fuel load for a PBM-3 model was 1,933 US gal (7317 litres). The prototype Mariner was successful in its flight test effort, apart from tail-flutter problems (which were solved by adding dihedral to the horizontal tail surfaces) and porpoising which had been forecast by the sub-scale Model 162A. Pilots reported that flight characteristics were good. The Navy accepted the XPBM-1 on 7 September 1939 and assigned it temporarily to Norfolk, Virginia.

US Navy service

The US Navy's first batch of PBM-1 Mariners went to patrol squadron VP-55, which soon redesignated as VP-74, followed by VP-56. Working with Catalina squadrons, Mariner pilots and crews flew training missions in near-war conditions in the stormy North Atlantic. The US Navy set up seadromes at Argentia, Newfoundland in July 1941 and at Reykjavik, Iceland the following month. VP-74's first skipper, Lieutenant Commander A. B. Vosseller, recommended that the Mariners be kept in Iceland during the severe winter. There, the squadron suffered its first fatality when a Mariner flew into a mountain in zero-zero weather on 1 November 1941.

Mariners carried out neutrality patrols prior to the events of Pearl Harbor. In summer 1941, experts installed on some PBM-1s the first British-type 'Ladder' radar, with antennas along the sides of the hull. When war arrived, the Navy began to employ the PBM-3 on anti-submarine and anti-shipping patrols. On 22 January 1942, VP-74 moved south with its PBM-1s for duty in the Caribbean and South Atlantic, with a detachment at Bermuda. This change tested the Mariner in a hot and humid climate as far south as Natal, Brazil. On 30 June 1942, a PBM-1 piloted by Lieutenant Richard E. Schreder sank *U-158* off Bermuda, the first German submarine to be claimed by a Mariner. The PBM Mariner was responsible for all or part of 10 U-boat kills during the war.

By early 1943 the PBM-3Cs were reaching Atlantic squadrons, and German U-boats, rather than endure attacks from the air while submerged, began to surface for shoot-outs with aircraft. Anticipating a fray with relatively lightly-armed patrol aircraft, the submarines often found the Mariner's seven 0.50-in machine-guns surprisingly formidable. Mariners sank 10 German submarines off the American coast and in Caribbean waters during 1943-44. A PBM-3C dubbed *Nickle Boat* and belonging to VP-74 was credited with assists in two U-boat sinkings: on 17 May 1943 with Lieutenant (junior grade) Harold Carey as pilot, and on 19 July 1943 with Lieutenant (junior grade) Roy Whitcomb at the controls. During the second engagement, the Allies captured the famous U-boat skipper Kapitänleutnant Guggenberger, who had sunk the HMS *Ark Royal*, and many of his crew. Since U-boats surfaced at night to recharge their batteries, many patrol squadrons followed the lead of VP-201 in employing the L-8C searchlight in late 1943.

Transport Mariner

To many sailors, the Mariner was the aircraft that took them to war and brought them back. Naval Air Transport Service (NATS) Mariners

Right: Coast Guard Mariners retained armament during World War II and in a number of cases encountered enemy submarines. 'Frisco-Dog' was a PBM-3S operating from CGAS San Francisco in April 1945.

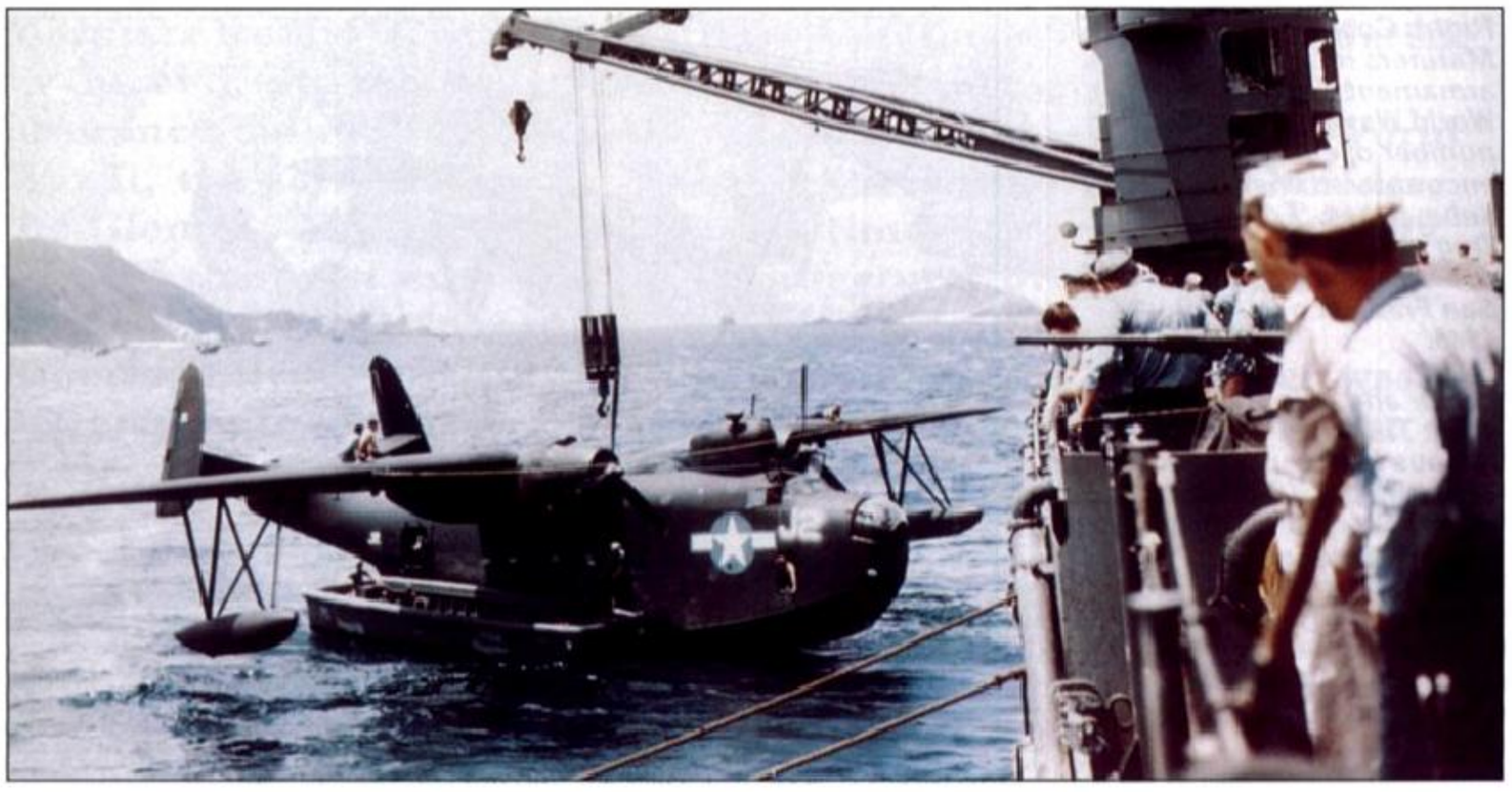
Below and below right: The most famous Mariner was undoubtedly VP-74's* Nickle Boat, *seen here on a morale-boosting visit to the Martin factory. PBMs sank 10 U-boats off the US and Brazilian coasts and in the Caribbean.

Below: The main seaplane ramp at Norfolk is seen sometime after spring 1944 with nearly 40 Mariners visible. Most of the aircraft are PBM-3Ss, while that at centre left is a PBM-3C or D.

A PBM-3D is refuelled in harbour at Saipan, 1945. Note the helmets worn by the crew – suggesting that the island's defences have yet to be completely neutralised. Note also the circuitous route taken by the fuel hose to the receptacle atop the wing.

A typical late-model Mariner crew consisted of 11 men: pilot, co-pilot, navigator, flight engineer, radio operator, radar operator, bomb aimer and four gunners. Three were officers and eight were enlisted men, although the informal dress of this PBM-5 crew blurs the distinction.

Below: Flying-boats are not suited to open sea operations and need sheltered waters to operate safely. They also need dedicated tender ships such as USS* Norton Sound, *seen lowering a PBM-5 'Nightmare' night shipping raider of VPB-26 into the waters of Kerama Retto anchorage – a former Japanese seaplane base in the Ryuku Islands – in mid-1945.



were flown by squadrons VR-1 at Pan American World Airways' Dinner Key Base, Miami, Florida (the company was not, at the time, referred to as 'Pan Am'), VR-8 at Patuxent River, Maryland, and VR-2 at Alameda, California. The Navy established VR-10 in the Pacific to ferry troops from Hawaii to the Southwest Pacific, New Zealand, and Australia.

British service

Twenty-seven PBM-3C flying-boats were acquired by the Royal Air Force's Coastal Command as the Mariner GR.Mk.1. These aircraft began to reach the United Kingdom in October 1943; on 20 October, No. 524 Squadron, a completely new unit, stood up at Oban for the specific purpose of gaining operational experience with the Mariner. The squadron took on eight aircraft and six crews, three who had flown Sunderlands and three who had flown Catalinas.

RAF crews put the Mariner through its paces in simulated day and night patrol missions. Although the aircraft was well liked by those who flew it, it was not adopted for RAF service, and No. 524 Squadron was disbanded on 7 December 1943. The aircraft were returned to the US.

Pacific war

US Navy squadron VP-202, formed at Norfolk in late 1943 with PBM-3Ds, was rushed to the Pacific battlezone to become the first Mariner patrol squadron based in the South Pacific. VP-16 and VP-216 followed, arriving in time for the invasion of Saipan. Additional PBM-3D squadrons began arriving in the Pacific after July 1944. The capture of Saipan's Tanapag Harbor seaplane base on 10 July 1944 eased operations, although PBMs had long since been making offshore flights. Saipan became the largest seaplane operating base in history until its Mariners, Catalinas, and Consolidated PB2Y Coronados began to transfer to Kerama Retto, Okinawa, in March 1945. The previous month, Mariner-equipped VPB-19 at Iwo Jima became the first US Navy squadron ever to use JATO (jet-assisted take-off) on combat missions.

In the Southwest Pacific the first Mariners in action belonged to VPB-20 and arrived at Manus on 25 October 1944. They were painted black and were supported by the tender USS *Tangier* (AV-8). Their nocturnal combat missions were known initially as Black Cat flights – the 'Black Cat' Catalinas had become legendary – but the name was soon changed to 'Nightmare'.

In post-war years the Mariner was a valuable tool of US policy in occupied Japan, China, and the western Pacific. PBM Mariners had an important role in Operation High Jump, the exploration of the Antarctic in 1946. VR-21 flew post-war PBM-5A amphibians to support the administration of the far-flung Marianas trust territory. Mariners of VPB-32 ran the 'Atomic Airline' supporting Operation Crossroads, the 1946 atomic tests at Bikini atoll.

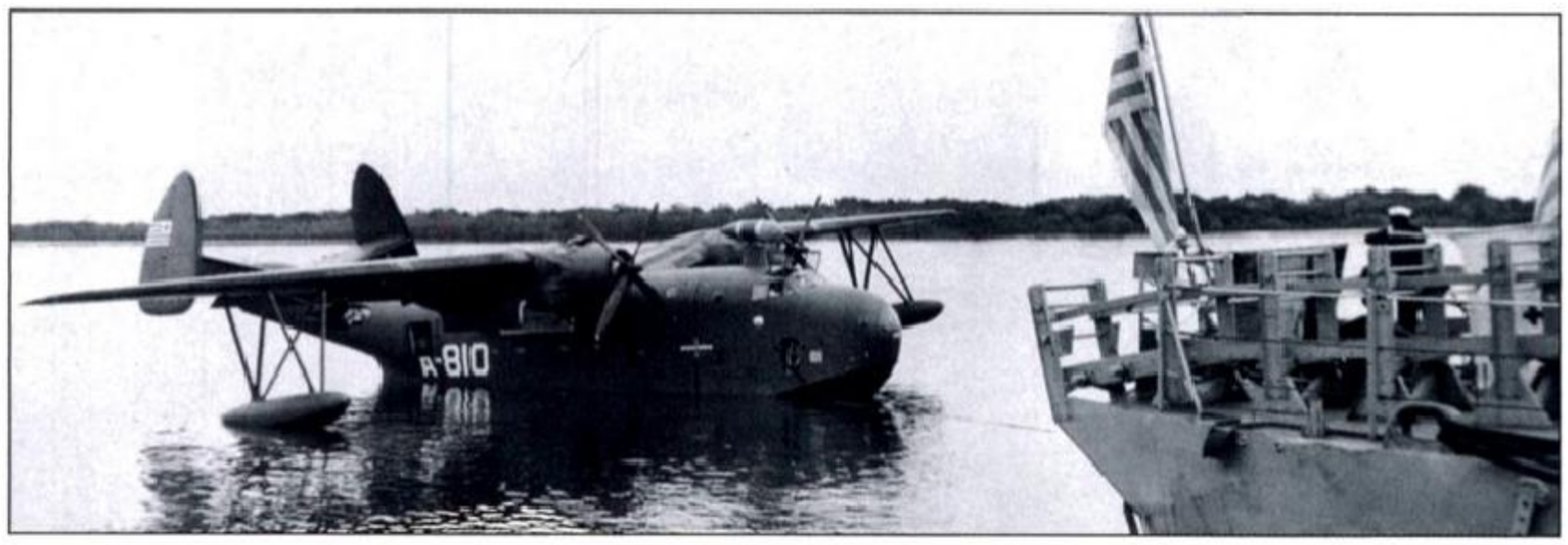
The US Coast Guard employed the Mariner in war and peace. The service took delivery of its first 27 PBM-3 Mariners in 1943, picked up several more PBM batches later, and retired its last in 1958. One source indicates that of 41 Mariners in the PBM-5 series (elsewhere listed as 49) employed by the Coast Guard, the

Up to 11 JATO rockets could be fitted to the PBM-5 to improve take-off performance. The rockets cut out as fast as they kicked in, though, and careful handling was needed to maintain a safe flying speed after they burned out.

Foreign Mariners

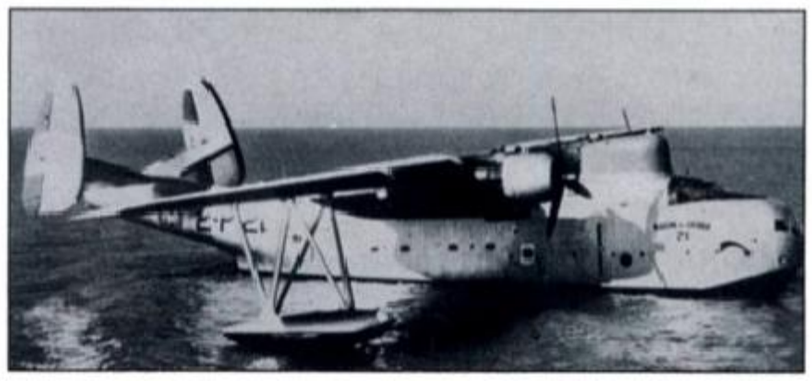
The Mariner achieved only limited export success compared to its contemporary, the Catalina. During the war, only the UK and Australia made limited use of the PBM. Post-war, the Mariner found a niche in South America and in the farthest-flung reaches of the Dutch colonies.

Above: The RAF's experience of the PBM was very limited. Only one Mariner unit was formed, in October 1943 (No. 524 Squadron), but returned its aircraft to the USA after the Air Ministry decided not to adopt the type. A total of 33 PBM-3Cs was received by the UK. Coastal Command Mariners are seen here in the USA before delivery.

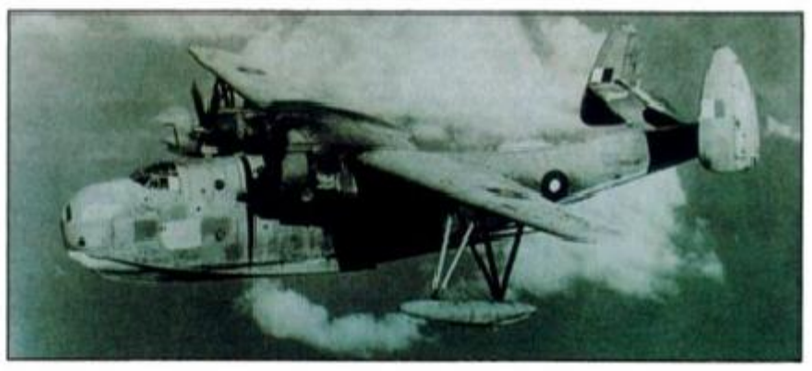


Above: Uruguay's three PBM-5s (A-810 to -13) replaced TBF and TBM Avengers on coastal patrol duties and also equipped the Escuela de Especialización Aeronaval (Naval Air Conversion School) between 1956 and 1963, when they were retired. Other PBM-5s were used commercially as freighters in Colombia.

Below: No. 321 Sqn of the Royal Netherlands navy (MLD) operated 17 PBM-5As on sea patrol and SAR duties, mostly from bases in the Far East and North Africa, including Biak, New Guinea, where 16-314 is shown. Six of the Mariners were written off in service; this poor record contributed to the type's retirement in 1960 after less than five years' service.



Above: Eight Mariners (including PBM-5S 2-P-21) were supplied to the Argentine navy's Esuadrilla Aeronaval de Exploración and used from c. 1948 to 1958/59, when replaced by P2V-5s.



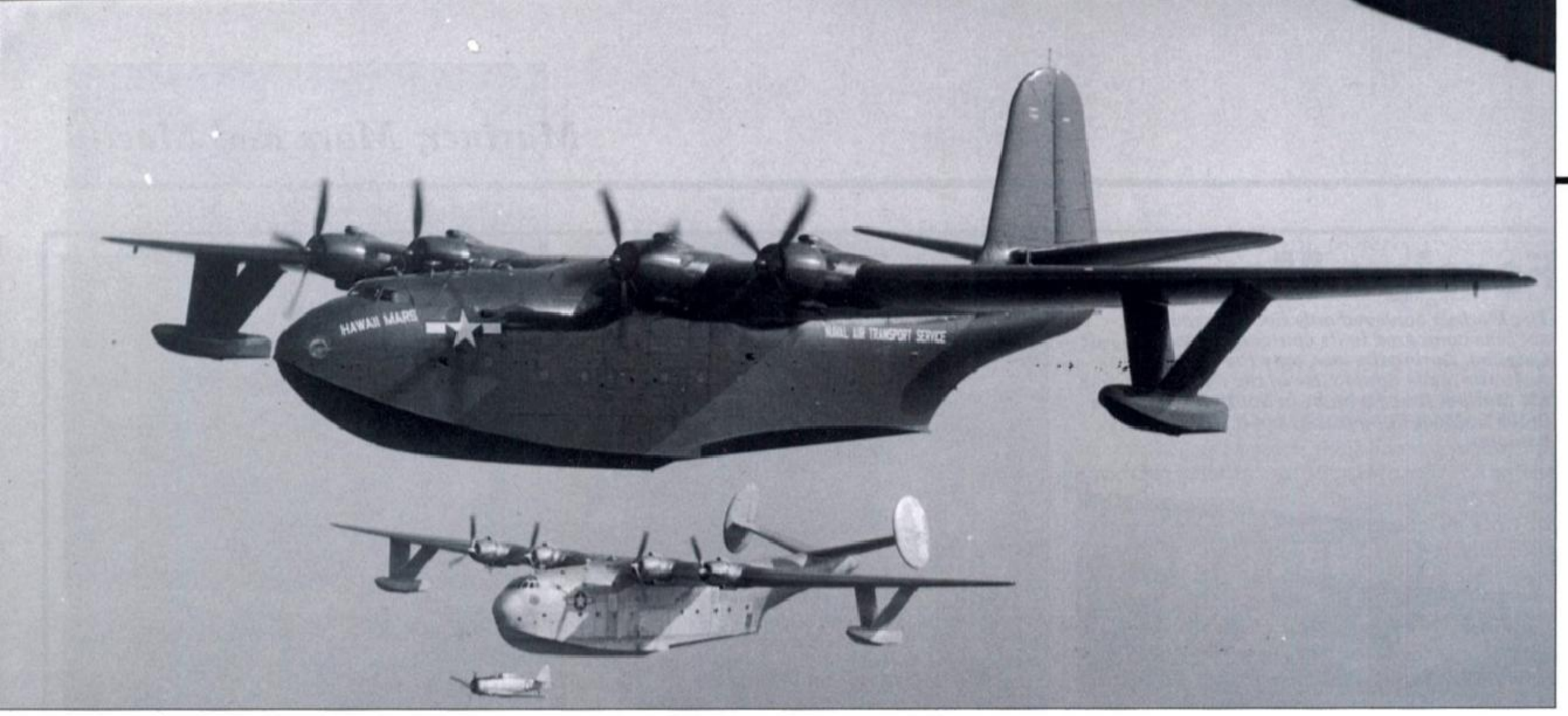
Above: A70-12 was one of 12 PBM-3Rs operated by the RAAF as transports in the Pacific. The first aircraft arrived in November 1943 under US Lend-Lease. All aircraft flew with No. 41 Squadron, although three were with No. 40 Squadron for a period. The patchy appearance is due to the overpainting of the previous USN markings.

service lost 15 during the war years. An exact listing of Coast Guard Mariners is almost impossible because the Navy and Coast Guard exchanged aircraft (e.g., the Coast Guard operated its sole PBM-3R transport for exactly a week and a half). One reliable source puts the Coast Guard totals at one PBM-3D, one PBM-3C, 36 PBM-3Ss, one PBM-3R (briefly), 48 aircraft in the PBM-5 series with various letter suffixes, plus one PBM-5A (very briefly).

In one of the more sombre moments of the Cold War, on 18 January 1953 a Coast Guard PBM-5G (BuNo. 84738) from the detachment at Sangley Point, Philippines, piloted by Lieutenant John Vukic, landed in 12-ft (3.65-m) seas along the Chinese coast to rescue crewmen from an Elint-gathering Lockheed P2V-5 Neptune of squadron VP-22 that had been shot down by Chinese shore batteries. An engine failed on take-off and the Mariner crashed. The mishap cost the lives of four Navy and five Coast Guard members.

In June 1950, the Mariner was the only US Navy flying-boat in the region when the North Koreans came across the 38th Parallel to attack South Korea. VP-47 was on the scene and was eventually joined by six other squadrons, including some activated Reserve units, which rotated deployments. For three years, PBM-5 and -5A Mariners operated around the clock in US Navy midnight blue from Iwakuni and Oppama, Japan, and other bases on the Korean peninsula. The Mariner flew alongside the Short Sunderland (the only RAF aircraft to participate in the Korean War). At one point during the Korean War, a number of PBMs

A row of primed PBM-3 hulls awaits final assembly and painting at Martin's camouflaged plant at Middle River. Here they share the ramp with two US Navy liaison types – a wheeled O2SU Kingfisher (centre) and a Howard GH Nightingale.



Above: The first JRM-1* Hawaii Mars *flies with its forebear, the XPB2M-1R* Old Lady, *and the company SNJ in July 1945. The prototype Mars, originally a bomber, was converted to a transport and then returned to Martin as a trainer.* Hawaii Mars *was lost in a landing accident on 5 August and the fourth JRM took the name.

The* Hawaii Mars *was launched in July 1945, but had yet to be christened when this picture was taken at Middle River. The JRM Mars transports were designed to support the island-hopping campaign in the Pacific, but the war ended before they could enter service.

were transported aboard the escort carrier USS *Windham Bay* (CVE-92), possibly the only time the Mariner was aboard a carrier.

During the 1950-53 conflict, Mariners flew patrols of nine to 12 hours duration, deep into the China Sea, often along the shores of China and North Korea. When the First Marine Division was surrounded by Chinese troops at the Chosin Reservoir in November 1950, a PBM Mariner pilot led a team that explored the idea of landing the seaplanes on the reservoir to evacuate troops. Unfortunately, ice on the water and low clouds in the air doomed the project. Later in the war, VP-47 made the only combat tour in PBM-5S2 aircraft. The apparent final combat action by a Mariner came on 2 October 1953, months after the Korean armistice, when a PBM-5S2 of VP-50 shook off an attack by MiG-15s and escaped riddled with cannon shell holes. The US Navy's final Mariners, like the British Sunderland, remained in service until the late 1950s.

A few Mariners made it to Latin America. In Colombia, the airline Madiera de Colombia operated five civil-registered Mariners and possibly a sixth circa 1948-50, to supplement steamships in river commerce (their initial civil registry numbers were C-56X, C-57X, C-77X, C-78X, C-79X before this country adopted an HK- code). The Uruguayan navy acquired three PBM-5S2s in May 1956. One was written off in a July 1958 accident and the two others may have served as late as 1963, one being airworthy until June 1966. The Argentine navy received two Mariners of an unknown variant in a civil purchase from a US supplier, circa 1950 (NL67903, NL67904), plus six PBM-5Ds in January 1959. The two civil-origin aircraft were disposed of in 1960. One of the -3Ds was lost in a mishap and the remaining five were sold as scrap in June 1966.

Martin Mars

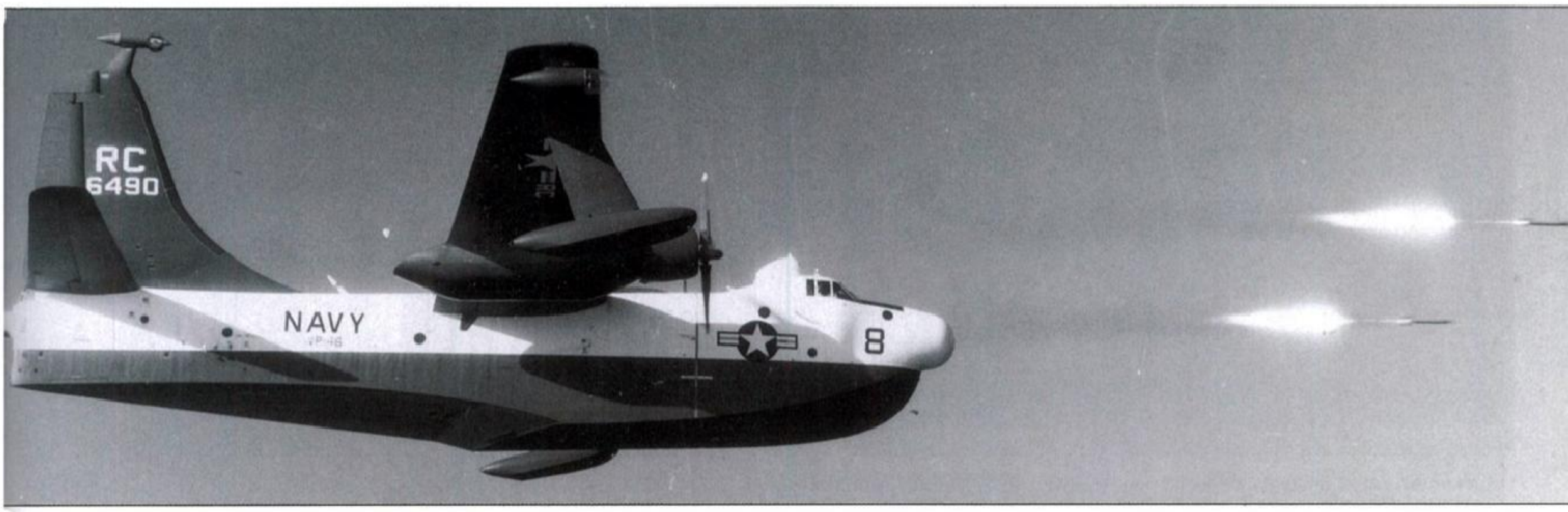
The tradition of alliterative names for huge flying-boats continued when Glenn L. Martin developed the Mars, or Model 170. By every standard of the time, the Mars was colossal. The US Navy placed an order on 23 August 1938 for a long-range maritime reconnaissance patrol bomber, which became the oversized XPB2M-1.

Martin conceived the Mars as a 'Sky Battleship' or 'Flying Dreadnought', able to carry not only bombs, mines and torpedoes but a battalion of Marine paratroopers as well. Company literature asserted that a single Mars could capture an enemy island; a squadron of them could "devastate Tokyo." The prototype was built as a bomber but entered service as the XPB2M-1R transport.

Dubbed *Old Lady* by Martin's chief test pilot Ken Ebel, the XPB2M-1R, piloted by Lieutenant Commander Bill Coney of VR-8, established a distance record for a flight from Patuxent River, Maryland to Natal, Brazil. This 4,375-mile (7040-km) journey was carried out at a gross weight of 148,000 lb (67131 kg) with a payload of 13,000 lb (5900 kg). In early 1944, the same Mars flew a 4,700-mile (7560-km) round-trip from Patuxent to Hawaii in 27 hours and 26 minutes, hauling 20,500 lb (9300 kg). The XPB2M-1R was transferred in January 1944 to VR-2 at Alameda, California.

The JRM series of Mars flying-boats that followed set many records for carrying passengers across transoceanic distances. The Mars 'boats featured two cargo/passenger decks with forward and aft stairways, two sets of crew's quarters, and fuel tanks in the hull below the lower deck. They were designed to carry 138 fully equipped troops or 100 litter patients with 10 attendants, or 35,000 lb (15900 kg) of cargo. A 5,000-lb (2270-kg) capacity bridge crane under the port wingroot facilitated cargo loading. Until their retirement in 1956, the Mars carried over 200,000 passengers without

The prototype Mars flying-boat was designated the XPB2M-1. When it first flew in June 1942, it was the largest aircraft ever flown. The colour scheme was a hangover from pre-war days.



The main offensive weapon for use against surfaced submarines carried by the Marlin was the 5-in (12.7-cm) HVAR. The rockets were aimed with a gyro gunsight mounted on the pilot's overhead panel – or by eyeball if the sub was about to dive. This VP-46 SP-5B is seen unleashing a pair during an exercise.

Right: A P5M-1 of VP-44 undergoes docking trials with the LST (Landing Ship, Tank)* Ashland, *10 April 1957. Floating U-shaped pontoon docks were a cheaper and more flexible method of supporting flying-boat operations than dedicated tender ships.

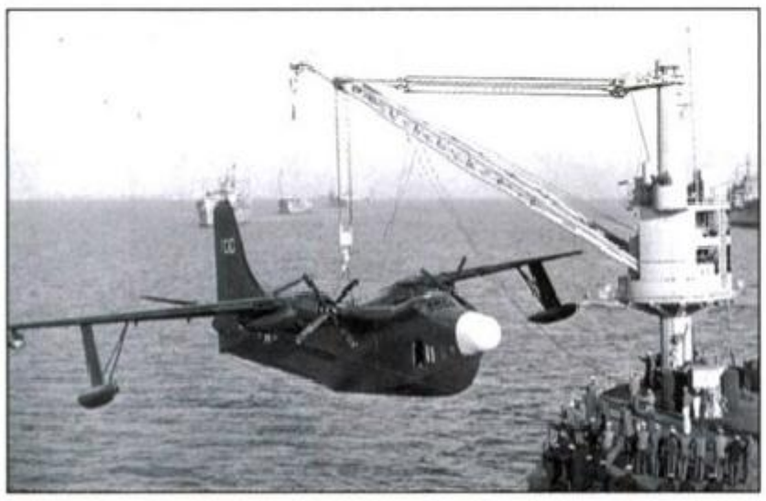
injury. Two of these ships, the *Philippine Mars* and *Hawaii Mars,* were still flying in Canada as fire-fighting water bombers as recently as 1995.

Martin Marlin

In 1944, Martin began design work on a flying-boat to replace the Mariner. The new aircraft was 8 ft (2.44 m) longer than the Mariner and 5 ft (1.52 m) higher, and introduced a single-step hull which increased the capacity of its fuselage. Based on a 26 June 1946 contract, Martin converted the planned final PBM-5 Mariner into a prototype for the new aircraft. In addition to the revised fuselage, this aircraft introduced Martin-patented hydroflaps, a pair of water-going speed brakes which could be extended from the lower rear of the hull. Operated by rudder pedals, these paddles could reduce the flying-boat's turn radius from 800 ft (245 m) to 300 ft (90 m).

In the 1940s and 1950s, the Pentagon's admirals imagined their convoys being sent to the bottom of the ocean by Moscow's deep-running submarines. The West's estimate of 600-800 Soviet submarines may have been exaggerated, but no anti-submarine weapon was deemed to be as effective as the flying-boat, which could be equipped with radar and sonar and carry a diversity of weapons. To meet the need, Martin began production of its first 25 P5M-1 Marlins in 1950.

The Marlin was easily recognised by its distinct, bulbous nose containing AN/APS-44A search radar. The crew numbered seven: pilot, co-pilot, navigator, radio operator, two electronics operators, and tail gunner. The Marlin was not pressurised and crews were later to complain that, unlike the Mariner, its bunk area was not soundproofed.



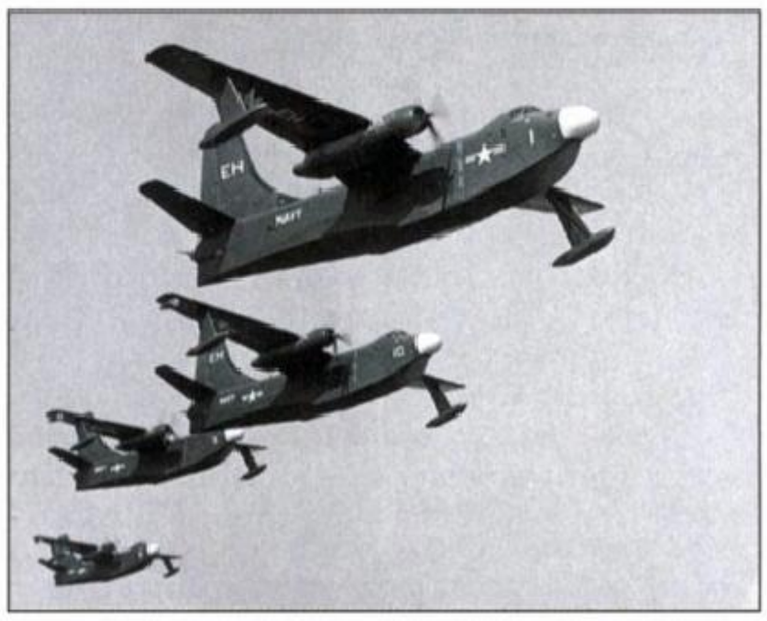
A VP-44 P5M-1 is hoisted aboard the aviation vessel USS* Currituck *(AV-7) in December 1952, the first time a Marlin came aboard this veteran seaplane tender. VP-44 was the first P5M unit.

Marlin in service

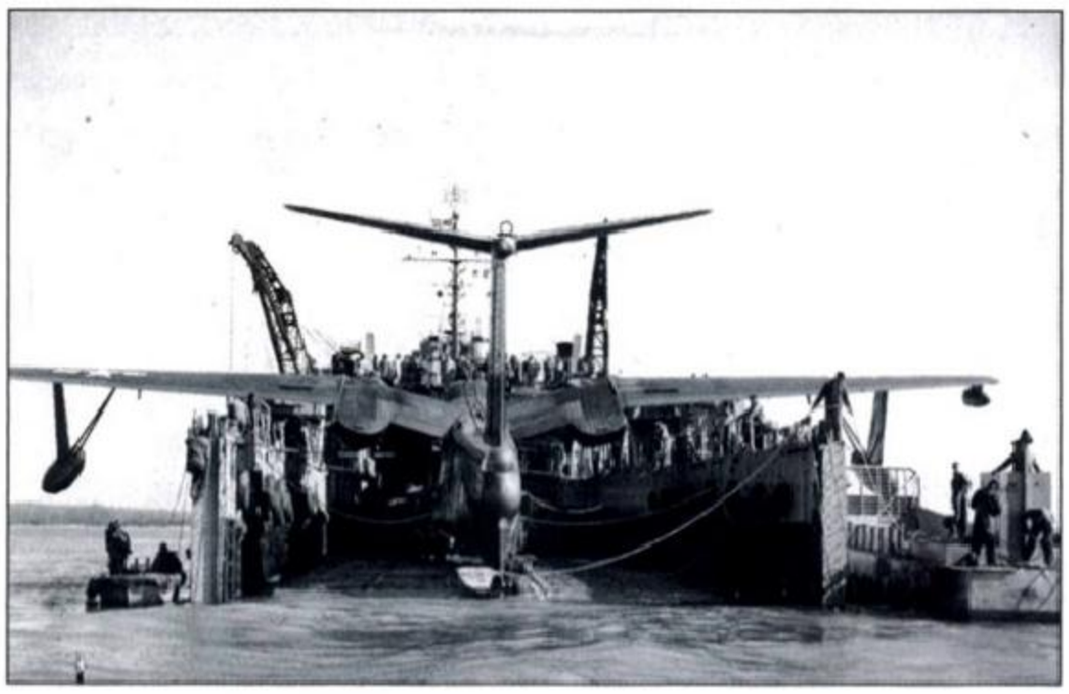
P5M Marlins began operating from Sangley Point, Philippines in 1954. That year, Marlins also deployed to the Mediterranean, supported by the seaplane tender USS *Currituck* (AV-7). Over the years, the Navy operated six tenders in the AV category, five in the smaller AVP category, and one submarine, USS *Guavina* (AO(SS)-362), converted for tending seaplanes. P5M-1 and P5M-2 models served together in the same squadrons throughout the 1950s.

During 1957-59, the US Navy embarked on an ambitious and costly programme to improve the ASW capabilities of the Marlin fleet and to carry out structural upgrades to all P5M-1s and P5M-2s in service. At the heart of these improvements were the Julie/Jezebel electronic suites and the Aircraft Integrated Display System (AIDS).

The Julie ECM (Electronic CounterMeasure, a misnomer) was an explosive echo ranging and localisation system which computed the position of a submarine target and displayed it at the operator's station. Jezebel was a search-detection system which employed sonobuoys to search, detect, and classify undersea targets. AIDS was a data assembly system which compiled information from the Marlin's other ASW systems, including the MAD (Magnetic Anomaly Detection) device mounted on the



VP-661 was one of nine patrol squadrons in service in 1951, all of them equipped with Martin products. Four of the unit's P5M-1s are shown in a rare formation picture.



This view shows the nacelle weapons bays on the fourth P5M-2, 135477. Usually, a droppable aluminium fuel tank was carried in the port bay and a pair of torpedoes in the starboard. Other weapons such as depth charges, mines and bombs could be carried in the bays or on wing racks. In addition to these weapons and the HVAR rockets, machine-guns could be mounted in the hatches.

Above: This sequence shows the docking of a P5M-2 aboard the LST* Ashland. *Note how much the wingspan overhangs the ship and that the floating pontoons used in the earlier docking trials have been dispensed with.

forward edge of the fin on the P5M-1 or the trailing edge of the T-tail on the P5M-2. The modified aircraft were redesignated P5M-1S and P5M-2S.

Structural modifications were carried out at the Martin Baltimore plant, and Julie, Jezebel and AIDS were installed at the Naval Air Development Center, Johnsville, Pennsylvania. To oversee and co-ordinate the ASW mission with this new gear, the modified Marlins introduced a new crew position, a TACCO (TACtical CO-ordinator), a non-pilot flying officer. Since the era of the Marlin, the US Navy has created the category of Naval Flight Officer (NFO) for non-pilots with such specialised duties, and the term TACCO survives, today, aboard the Lockheed S-3B Viking ASW aircraft.

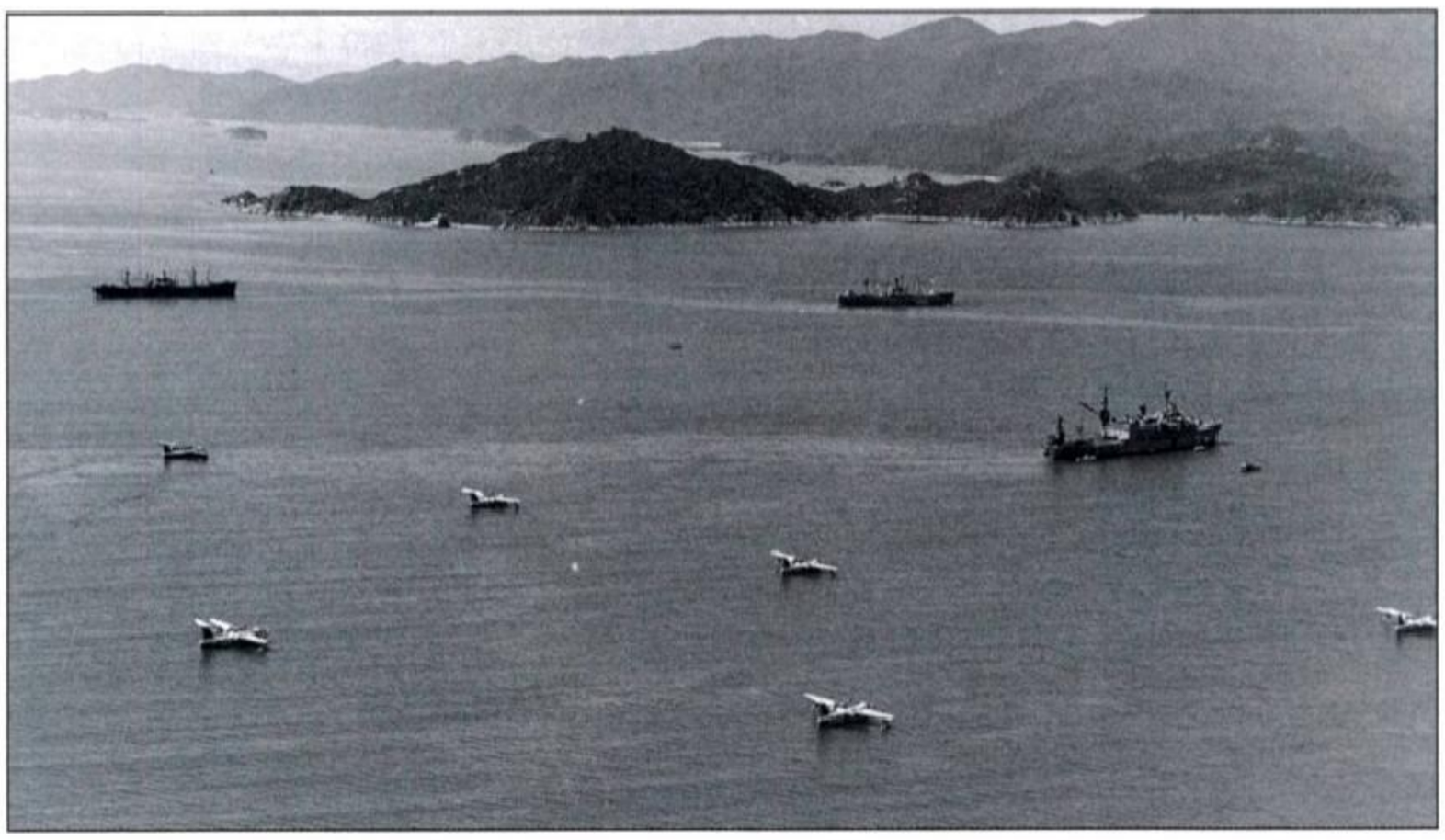
While the US Navy was busily employing the Marlin to stalk Soviet submarines, the US Coast Guard operated the type briefly for search and rescue duties. The Coast Guard accepted seven P5M-1Gs and four P5M-2Gs, which were identical to the Navy aircraft but with ASW equipment removed. Unlike the Navy, the Coast Guard routinely landed the Marlin on the open ocean in emergencies to rescue victims of disasters at sea. These aircraft were eventually returned to the Navy as P5M-1T and P5M-2T trainers.

French deliveries

France became the only overseas user when it took delivery of 10 P5M-2 Marlin flying-boats. Intended to replace the ageing Sunderland MR.Mk 5, the aircraft were delivered in April 1959 for use by 27 Flottille at Dakar, French West Africa (now Senegal) as the nucleus of a new ASW squadron which would operate as a NATO unit with allied naval air forces.

Aéronavale Marlins operated in extreme conditions of tropical heat and humidity, often flying patrols of up to 14 hours. They were less roomy than the Sunderlands and, in the opinion of French mechanics, more difficult to maintain. Apart from a collision between two aircraft on the surface of the sea, which did not cause serious damage, France operated the Marlin without a mishap. French Marlins were initially painted grey-green with white under-surfaces and with the naval flash on the rudder. The French eventually added a white reflective panel at the top of the aircraft. France operated the aircraft until August 1964 then, as a consequence of its decision to withdraw from the NATO command structure, returned them to the US Navy.

Beginning in February 1965, Marlins operated from Sangley Point, Philippines, in Market Time (anti-infiltration) patrols along the



One of the 12 P5M-2s supplied to the Aéronavale is seen taxiing near the Martin plant at Middle River, on an arm of Chesapeake Bay. The Marlin achieved less export success than the Mariner, although Australia, New Zealand and Japan showed an interest; the latter eventually developed the similar Shin Meiwa PS-1.

Left: The swansong of the flying-boat in United States' service was in Vietnam, where SP-5Bs of three VP squadrons undertook Market Time patrols against enemy supply craft. This view shows aircraft of VP-40 around the tender USS Salisbury (AV-13) at Cam Ranh Bay, in August 1966.

Vietnamese coast. Crews took off on these missions using JATO. They often flew armed with two door-mounted M60 machine-guns, wing-mounted 5-in HVAR, and nothing else, since they were expected to mark targets for others. The last deployment was made by VP-40 in 1967. Following the final combat mission, the last official flight by a US Navy seaplane squadron was made on 6 November 1967 when an SP-5B made a routine flight from North Island. Soon after, all but one of these elegant flying-boats were stripped for useful parts and cut up for scrap.

Over 8-12 July 1968, the final flight by a Marlin took place when an SP-5B flew from North Island to NAS Patuxent River, Maryland. This aircraft had been earmarked for preservation at the Smithsonian Institution's National Air and Space Museum in Washington, DC. The aircraft (BuNo. 135533) was subsequently shipped by land to the National Museum of Naval Aviation in Pensacola, Florida, where it is on display today.

The PBM Mariner was continuously deployed in actual operations from 1940 to 1956, longer than any other American seaplane. The Marlin continued this tradition until 1967. Martin's house newsletter, the *Star*, claimed that the Baltimore factory where Mariner flying-boats were manufactured was the largest aircraft assembly floor in the world. Totals of 1,366 Mariners and 284 Marlins were built, the latter figure including 160 P5M-1s, seven P5M-1Gs, 113 P5M-2s and four P5M-2Gs.

Robert F. Dorr

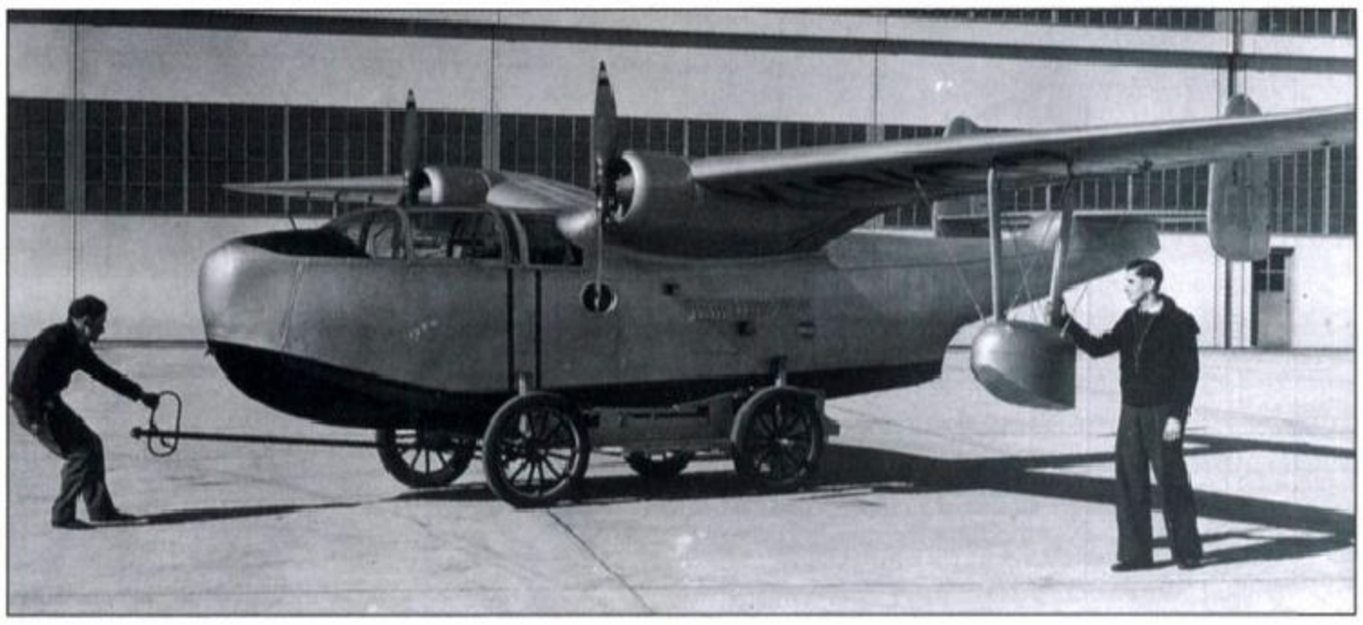
The last US Navy flying-boats were the SP-5Bs of VP-40, which flew its last operational missions over Vietnam in late 1967. Tail guns were not fitted, but rockets and door guns were available for attacks against North Vietnamese vessels.

Mariner Variants

Model 162A

The Martin Model 162A was a clever and unusual approach to bringing into being the concept behind an early flight test programme – a three-eighths size, man-carrying flying model of the planned XPBM-1 prototype. The 162A was economically built, using wood framing covered with aluminium. It is believed to be the first flying scale model of a production aircraft ever built in the United States. Since no radial engines were small enough to fit into the scaled-down engine cowlings, the 162A's fuselage became the location for a single 120-hp (90-kW) Chevrolet inverted-vee, four-cylinder radial engine that powered both 7-ft (2.13-m) propellers with V-belts. The 162A *Tadpole Clipper* began flight tests aimed at finalising the hull design for the PBM in December 1937. The model has survived and is currently on display in the Baltimore, Maryland Museum of Industry.

The* Tadpole Clipper *was a manned scale model incorporating the main features of the Mariner design.* Popular Flying *magazine saw it as a promising method of developing future "... airliners so much larger than ... [those of the day] ... that the average mind will be unable to appreciate their dimensions."



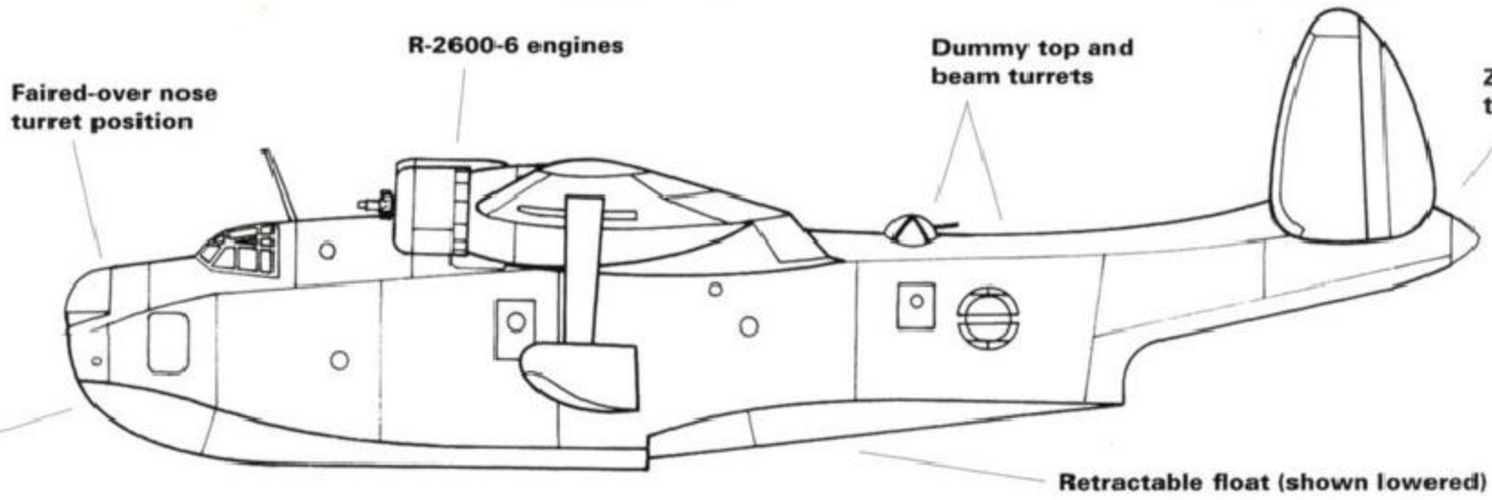
Registration no. X19168 (1)

XPBM-1 (Model 162)

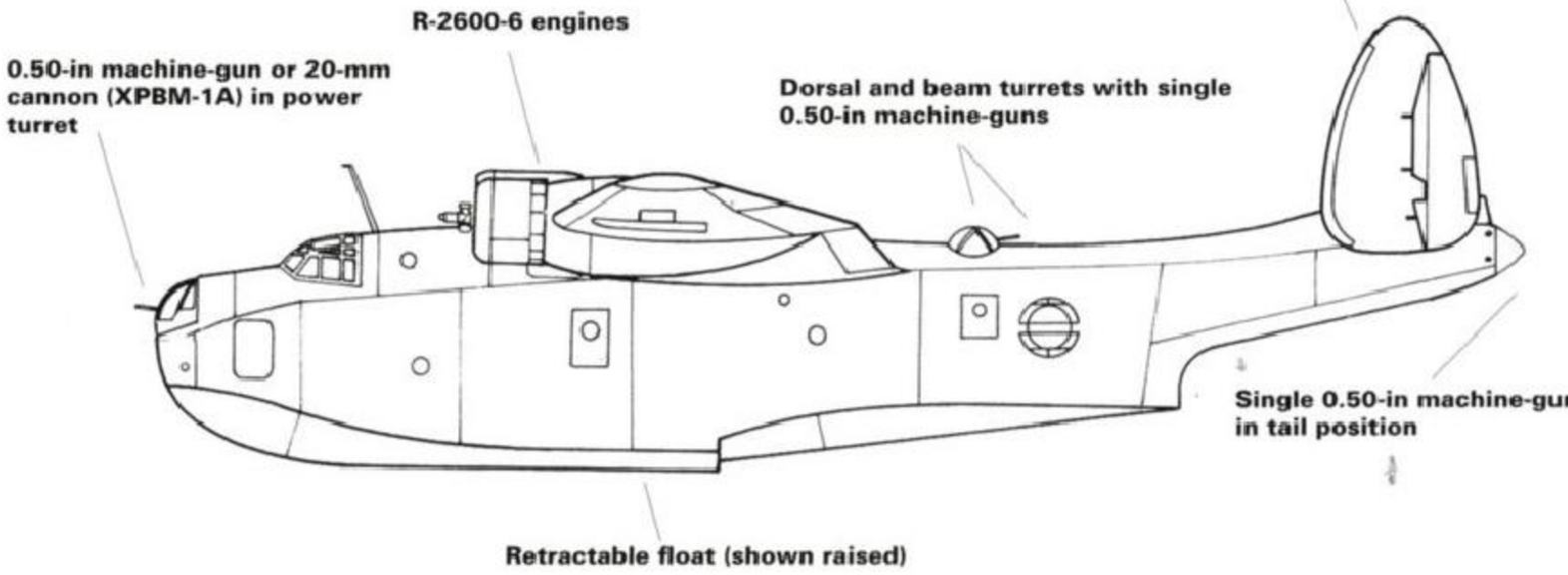
The Martin XPBM-1 prototype (BuNo. 0796) established the configuration of the Mariner series: a robust, high-wing, twin-engined monoplane flying-boat. It differed from later production aircraft in having retractable wingtip floats. The XPBM-1 was powered by two 1,600-hp (1194-kW) R-2600-6 Cyclones driving three-bladed propellers. This aircraft had dummy turrets (at first) to represent armament of five 0.50-in (12.7-mm) machine-guns and an optional, nose-mounted 20-mm cannon. The tailplane was originally without dihedral, although this was later modified to follow the angle of the inboard section of the gull wing, giving the Mariner what some call a 'pinwheel' tail. The XPBM-1 made its first flight on 18 February 1939, and shared the company Model 162 designation with the XPBM-1A and PBM-1.

BuNo. 0796 (1)

This view of the XPBM-1 on an early test flight shows the original level tailplane. Markings were basic – fuselage 'US Navy' titles, above-wing national insignia with BuNo. and designation on fin and rudder.


R-2600-6 engines
Faired-over nose turret position
Dummy top and beam turrets
Zero-dihedral tailplane
External racks for 2,000 lb (907 kg) of bombs or depth charges inboard of nacelles
Retractable float (shown lowered)

PBM-1 (Model 162)


Dihedralled horizontal tail
R-2600-6 engines
0.50-in machine-gun or 20-mm cannon (XPBM-1A) in power turret
Dorsal and beam turrets with single 0.50-in machine-guns
Single 0.50-in machine-gun in tail position
Retractable float (shown raised)

The Navy placed an order for 20 production PBM-1s on 18 December 1937, 14 months before the type's first flight. Martin began delivery of 21 production PBM-1s in September 1940. The type was outwardly identical to the prototype except for contour changes in the turret areas and atop the hull forward of the tail. The 'dash one' retained five 0.50-in (12.7-mm) machine-guns but dispensed with an optional, nose-mounted 20-mm cannon. The PBM-1 series retained retractable wing floats.

BuNos 1246, 1248/1266 (21)

A PBM-1, probably of VP-74 (the redesignated VP-55) takes off in the early-war blue grey over light grey colour scheme. Note the retractable wing floats fitted only to the PBM-1s.

The first Mariners were delivered to squadrons VP-55 and -56, part of Patrol Wing Five at Norfolk, in late 1940. This view of BuNo. 1262, possibly 55P3 of VP-55, dated May 1941 shows the stressed-skin wings to great effect.

A PBM-1 is seen with an unusually large numeral on the centre fuselage. This view dates from prior to December 1941 when the red/white stripes were introduced to the rudder surfaces.

XPBM-2 (Model 162)

The Navy converted one of the initial 21 PBM-1s to XPBM-2 standard in an attempt to develop a strategic bomber able to carry large bombloads up to a distance of 4,000 miles (6440 km). The XPBM-2 had extra fuel tanks (raising capacity from 2,700 to 4,815 US gal/10220 to 18225 litres) and a strengthened hull for launch from a giant barge-mounted catapult being developed by the Naval Aircraft Factory in Philadelphia.

The Germans had perfected the catapult concept for flying-boats, and the US Navy's version was completed in 1942. Baldwin Locomotive Works constructed the Type XH Mark 3 catapult that was installed on a Catapult Lighter (AVC-1) intended as a mobile base. The vessel had a slip with inclined railway to get the PBM onto the catapult car. The concept was tested with dead weights but, by the time tests were well advanced, the Navy dropped its plans for this kind of long-range bombing capability.

The sole XPBM-2 (possibly after reverting to the PBM-1 designation) flew for some time at the Naval Air Material Command at the Philadelphia Navy Yard before being struck on 30 June 1944.

BuNo. 1247 (1)

PBM-3 (Model 162B)

The PBM-3 shared the designation Model 162B with its PBM-3R offspring. In autumn 1940 Martin agreed to build 379 PBM-3s in a new factory at Middle River (in Baltimore), financed by the government. When all aircraft in the PBM-3 series are counted, Martin's total production run nearly doubled the planned figure at 677 (32 PBM-3s, 18 PBM-3Rs, 274 PBM-3Cs, 259 PBM-3Ds, and 94 PBM-3Ss). With the exception of the PBM-3D model, all 'dash three' series aircraft were powered by 1,700-hp (1270-kW) R-2600-12 Cyclones. Early in the -3 production run, the manufacturer shifted from three- to four-bladed propellers, and cooling fans were installed on the engines of a number of PBM-3s.

The PBM-3's engines were housed in elongated nacelles, each able to house four 500-lb (227-kg) bombs or depth charges. The PBM-3 introduced large, braced, non-retractable floats. The tail of the PBM-3 was modified with the addition of four Shannon vortex airfoils mounted over and under each stabiliser at the rudder. For devising this final solution to the Mariner's long-standing tail problems, Martin inducted test pilot Ellis 'Sam' Shannon into the 'Order of the Purple Martin'.

VP-74 took delivery of a few PBM-3s with single guns in the turrets, no radome, and three-bladed propellers. These aircraft carried out fleet testing duties, paving the way for production Mariners that followed.

BuNos 6455/6458, 6471/6498 (32)

Above and below: PBM-3s are seen at Norfolk circa late 1942, before the introduction of three-tone camouflage to the patrol squadrons. The lower view shows the dorsal turret in the retracted position.

The PBM-3 introduced a completely revised engine nacelle which incorporated a weapons bay with hinged doors. Additional improvements included power turrets and new waist hatches.

XPBM-3E (Model 162B)

The second PBM-3 tested new AN/APS-15 search radar and was designated XPBM-3E ('E' for electronics). This radar installation was subsequently placed aboard PBM-3Cs.

BuNo. 6456

PBM-3R (Model 162B)

PBM-3R no. 404 of VR-6 sits moored at NAS Banana River with the Sikorsky S-40 American Clipper, then (1943) a navigation trainer.

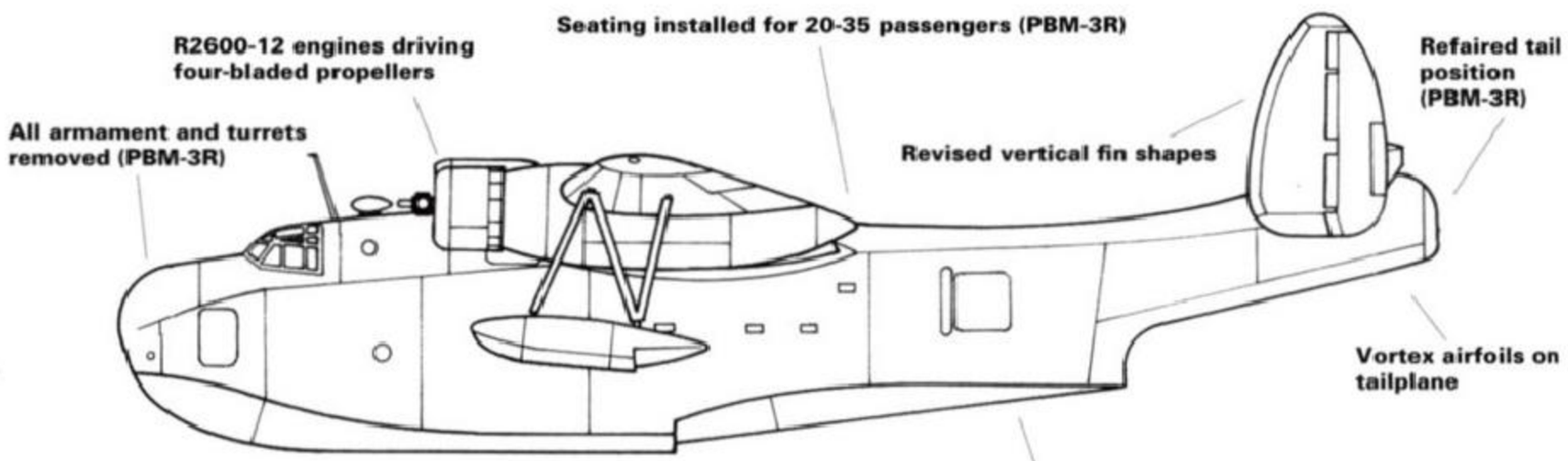
The PBM-3R transport (its role signified by the 'R' suffix) was stripped of armament and fitted with strengthened cargo floor, cargo loading doors, and provision for 20 passengers. In practice, Mariners at times carried double that number of passengers. Eighteen PBM-3Rs came from new production and 31 more from modified PBM-3 aircraft. These ships were the first in the 'dash three' series to be delivered. The -3R was also the first model to be fitted entirely with four-bladed propellers.

PBM-3Rs carried passengers for the Naval Air Transport Service (NATS), often with former airline pilots at the controls. The Royal Australian Air Force received 12 PBM-3Rs between November 1943 and January 1944 (RAAF numbers A70-1 to A70-12), which were assigned to No. 41 Squadron in New Guinea.

BuNos 6459/6470, 6499/6504 (18 new-build)

A PBM-3R with the three-tone scheme and later insignia sits on its beaching gear, 22 May 1944. The sealed bomb doors are visible.

***A PBM-3R of NATS** has the (48-star) Stars and Stripes painted on the nose. Mariners so marked served alongside Boeing B-314 and Martin M-130s with civilian registrations.*

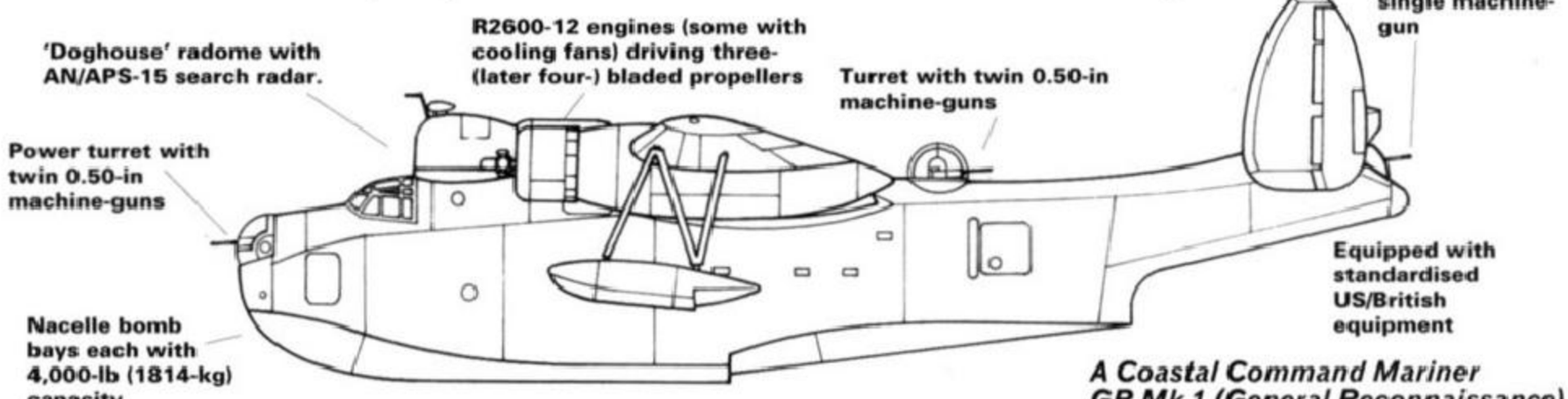

R2600-12 engines driving four-bladed propellers
Seating installed for 20-35 passengers (PBM-3R)
Refaired tail position (PBM-3R)
All armament and turrets removed (PBM-3R)
Revised vertical fin shapes
Vortex airfoils on tailplane
Fixed floats
Square hatch with air/spray deflector

PBM-3C (Model 162C) (Mariner GR.Mk 1)

Martin built 274 aircraft as PBM-3C models powered by R-2800-12s with dual 0.50-in (12.7-mm) machine-guns in three power turrets (one of them in an improved tail-gun position), plus two more hand-held guns firing through side windows in the waist. Most left the factory with an empty 3-ft (0.9-m) plastic dome or 'doghouse' rising behind the cockpit, in which the Navy installed top-secret AN/APS-15 radar sets at Norfolk, Virginia.

Thirty-one of these aircraft were to have served with the Royal Air Force as the Mariner GR.Mk 1 (serials JX100/JX131). During their brief time in British service they carried standard Coastal Command colours of overall white with grey upper surfaces. The RAF preferred PBY Catalinas and four-engined Short Sunderlands, and sent the Mariners back after a brief period of testing. Some served with the US Navy as PBM-3Bs.

BuNos 6505/6754, 01650/01673 (274)


'Doghouse' radome with AN/APS-15 search radar.
R2600-12 engines (some with cooling fans) driving three- (later four-) bladed propellers
Turret with twin 0.50-in machine-guns
Revised tail gun position with single machine-gun
Power turret with twin 0.50-in machine-guns
Equipped with standardised US/British equipment
Nacelle bomb bays each with 4,000-lb (1814-kg) capacity

A Coastal Command Mariner GR.Mk 1 (General Reconnaissance) of the only RAF squadron, No. 524, takes off at Oban on 7 December 1943, the day the unit disbanded.

This view of an early PBM-3C without radar shows the single gun rear turret and the 'Shannon Fix' vortex airfoils on the tailplanes.

PBM-3B (Model 162C) (Mariner GR.Mk 1)

The PBM-3B designation applied to PBM-3C/Mariner GR.Mk 1 aircraft returned to US service by the Royal Air Force. The 'B' suffix usually indicated an armament change, but it is unknown if these Mariners were modified in any way. They apparently merged into the Mariner force, many still in their British paint schemes.

On delivery, the RAF Mariners were sent to SARO at Beaumaris in Anglesey for fitting of ASV radar and other equipment. JX103 is seen there, in the incongruous setting of Fryar's House's front lawn, August/September 1943.

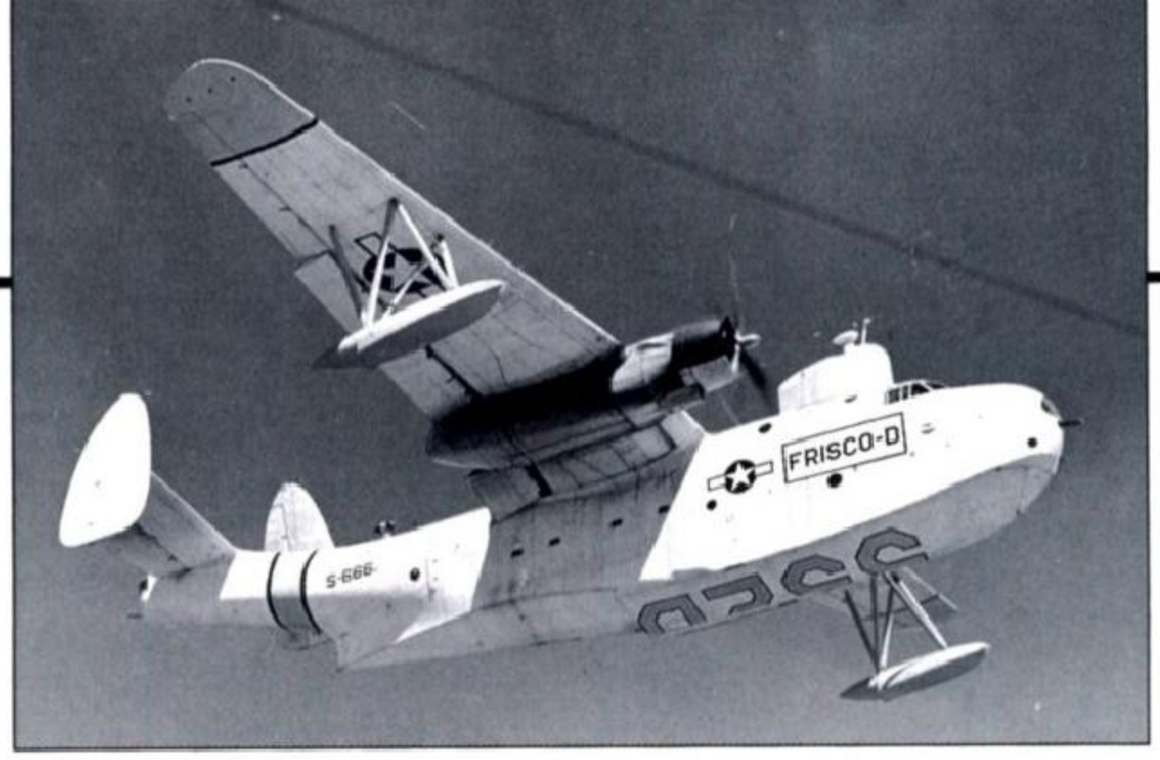
PBM-3S (Model 162C)

The PBM-3S, which followed the PBM-3C on the production line, was optimised for anti-submarine work and delivered in the British anti-submarine colour scheme of white with gull grey top surfaces. It was

Mariners searched the Atlantic for U-boats from Alaska to Brazil. Here VP-5 PBM-3Ss fly over Rio.

powered by R-2600-12s, many of which were fitted with cooling fans. The PBM-3S omitted armour and power turrets (which were faired over) for longer combat range, which was more than 25 per cent greater than that of the PBM-3C. Designers moved the navigator's table to the waist position, where the starboard gun was removed, leaving only the port waist gun in position. Martin built 94 PBM-3S aircraft; in addition, others were converted from PBM-3C standard at Navy depots. The PBM-3S was used exclusively in the Atlantic, including on patrols around the Panama Canal. Twenty-seven were transferred to the Coast Guard in 1944 and used by that service until the end of the war.

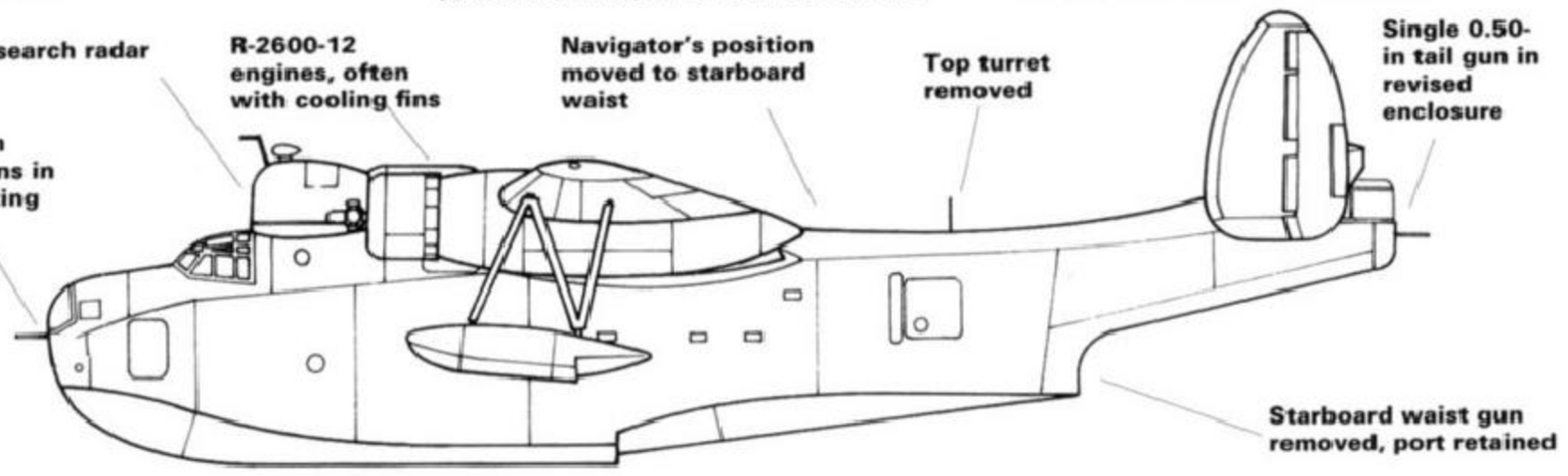
BuNos 6693 (XPBM-3S), 01674/01728, 48125/48163 (94)



Above: A San Francisco-based PBM-3S is seen in April 1945. At the war's end, USCG aircraft returned to natural metal colour schemes .

Right: Engine reliability was a problem with the PBM. This view shows the cooling fans first introduced on the PBM-3S.

PBM-3Ss are seen on a tender with a Curtiss SOC Seagull. Relatively few PBMs saw action in the overall gloss sea blue colour scheme.


AN/APS-15 search radar
R-2600-12 engines, often with cooling fins
Navigator's position moved to starboard waist
Top turret removed
Single 0.50-in tail gun in revised enclosure
Twin 0.50-in machine-guns in fixed mounting
Starboard waist gun removed, port retained

PBM-3D (Model 162D)

After testing a single XPBM-3D prototype (BuNo. 6656), Martin produced the PBM-3D patrol bomber (following the PBM-3C and PBM-3S ASW aircraft) from 1943 with features intended to help in the Pacific island-hopping campaigns, including Norden bombsight, more powerful engines, more crew armour, and self-sealing fuel tanks.

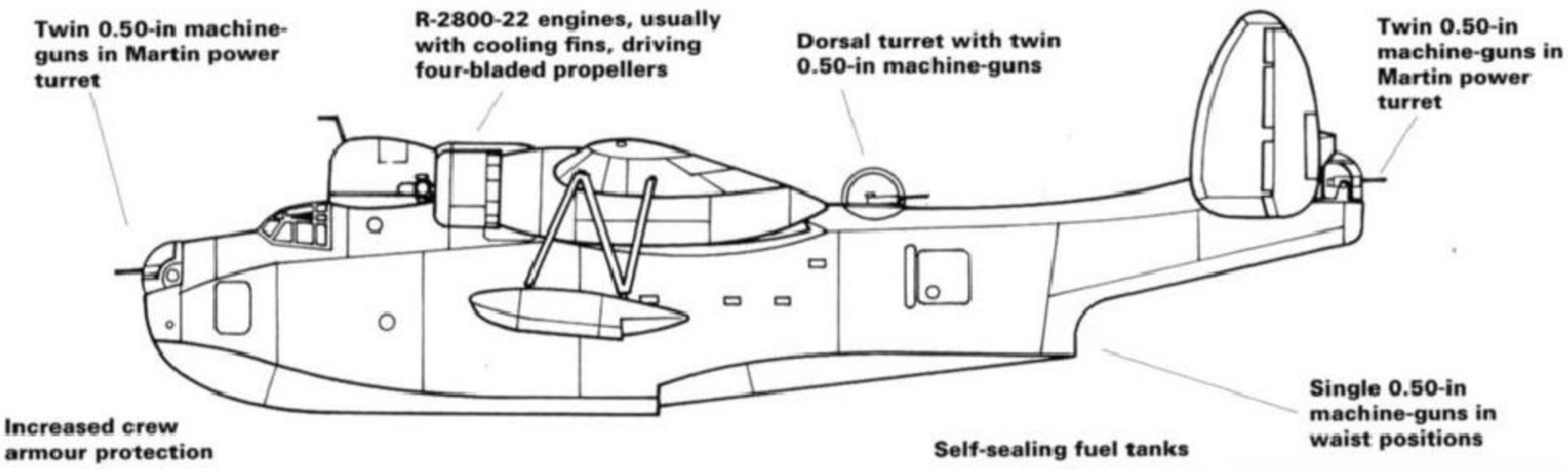
The PBM-3D introduced the 1,900-hp (1417-kW) R-2800-22 Cyclone driving four-bladed propellers and was able to accommodate internally bullet-proof, Martin-built fuel bladders for improved range. Sadly, the -22 engines had faulty valve seats which hamstrung the PBM-3D until all of the early engines were changed out. The PBM-3D was the heaviest of the wartime Mariners and, like others in the -3 series, was deemed underpowered even when its engines were working well. The US Navy's operating manual claimed the PBM-3D would fly on a single engine, but pilots found that an 'engine out' situation almost always meant a ditching at sea.

The PBM-3D was armed with eight 0.50-in (12.7-mm) machine-guns, two in the nose position, two in the dorsal position, two in the tail, and one at each waist station.

The manufacturer halted production of the PBM-3D at 259 airframes when it became possible to replace this model with the more powerful PBM-5.

BuNos 48124, 48164/48223, 45205/45274, 45277/45404 (259)

Combat experience with the Mariner led to numerous improvements to its survivability and operational efficiency being incorporated on the PBM-3D. Performance suffered due to the increased weights, however.


Twin 0.50-in machine-guns in Martin power turret
R-2800-22 engines, usually with cooling fins, driving four-bladed propellers
Dorsal turret with twin 0.50-in machine-guns
Twin 0.50-in machine-guns in Martin power turret
Increased crew armour protection
Self-sealing fuel tanks
Single 0.50-in machine-guns in waist positions

Left: A PBM-3D is hoisted aboard a tender at Saipan in 1945. The Mariner's exploits are usually overshadowed by those of the Catalina, but by 1944 the PBM had supplanted the PBY in the drive towards Japan.

The huge air station at Norfolk was the base for hundreds of Mariners by 1943. Fleet Air Wing 5 trained units for Atlantic patrol and FAW-9 commanded patrol operations. This PBM-3D is being launched from Breezy Point ramp.

PBM-4 (Model 162E)

The designation PBM-4 went to a Mariner with huge 2,700-hp (2015-kW) Curtiss Wright R-3350 Cyclone 18-cylinder radial engines – the obvious remedy to earlier -1, -3C and -3S Mariners being sorely underpowered. The Navy ordered 180 PBM-4s in 1941, anticipating the inadequate power that was a flaw of the PBM-3 series. The total number planned was apparently 230. Some sources refer to this variant as the PBM-4E.

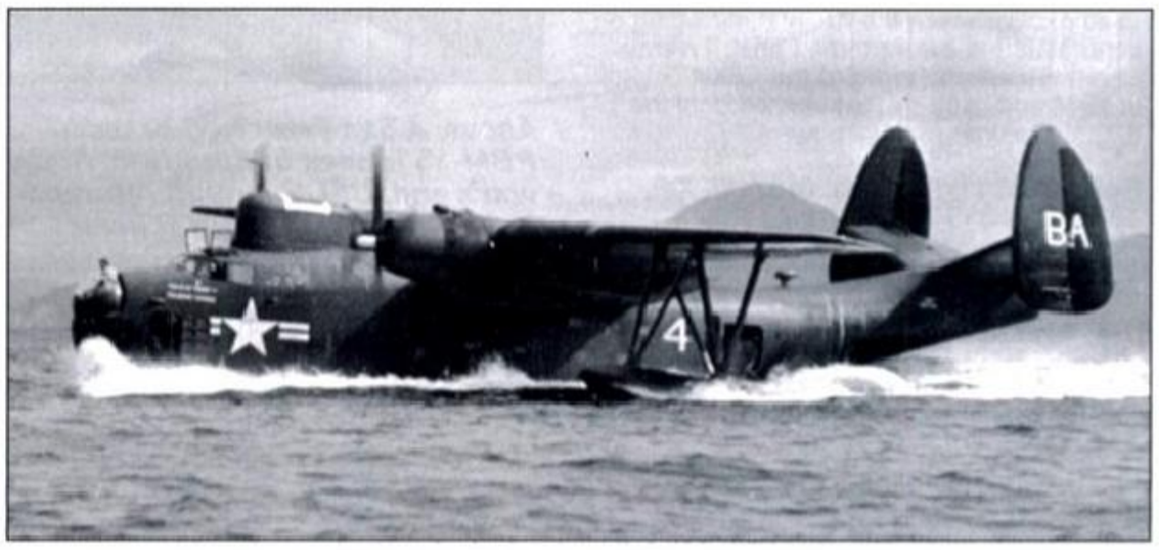
In addition to the PBM-4, the Navy was evaluating the Boeing XPBB-1 Sea Ranger which was intended for the same powerplant and would have been manufactured at Boeing's Renton, Washington plant. In a complicated series of moves aimed at freeing up both the Renton facility and the supply of R-3350 engines for the B-29 Superfortress, the Navy cancelled the PBB Sea Ranger, cancelled the PBM-4 Mariner, received a number of B-24 Liberators under the designation PB4Y-1, and held aside the idea of a Martin-produced version of the PBB (see P4M-1). These dealings spelled an end to the PBM-4 concept before an aircraft could be built or flown.

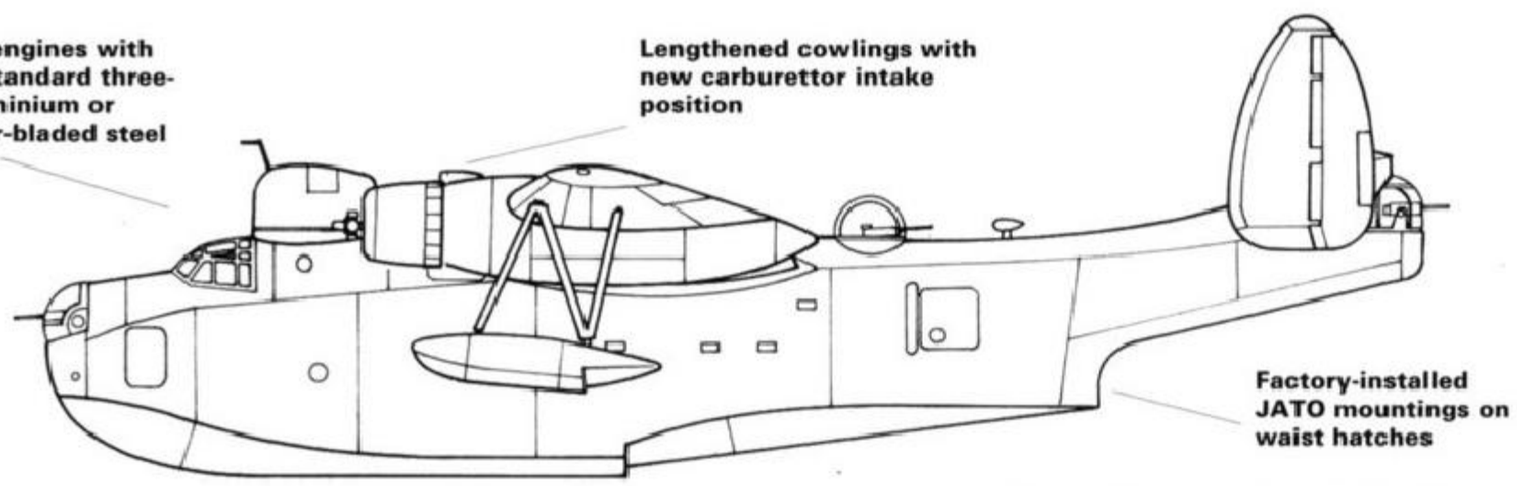
PBM-5 (Model 162F)

Martin built 628 aircraft in the definitive PBM-5 series. The first of two XPBM-5 prototypes flew in May 1943 and introduced powerful Pratt & Whitney R-2800-34 Twin Wasp radial engines (as an alternative to the R-3350) in the hope of finally giving the Mariner adequate power. The first production ship followed in September 1944, and this model remained in production until July 1947. The 'dash five' had provision for up to 11 jet-assisted take-off (JATO) bottles. The engine cowlings were slightly lengthened and were more noticeably tapered, and the air intakes were moved rearward on the top of the cowlings.

The PBM-5 Mariner became the standard model in the final segment of the Pacific war. The PBM-5 radome was a solid, contoured structure above and behind the flight deck. Many aircraft in the PBM-5 series went to the Coast Guard, the first being BuNo. 59148 which was accepted on 9 December 1944. One aircraft originally slated to be a PBM-5 (BuNo. 98616) became the prototype XP5M-1 Marlin and later the M-270 test ship.

BuNos (XPBM-5) 45275/45276 (2); PBM-5 45405/45444, 59000/59348, 84590/84789, 85136/85160, 98602/98615 (628)




R-2800-34 engines with Hamilton-Standard three-bladed aluminium or Curtiss four-bladed steel propellers
Lengthened cowlings with new carburettor intake position
Factory-installed JATO mountings on waist hatches

Above: With hatches open and crew preparing for docking, a VP-47 PBM-5 taxis to the tender USS Gardiner's Bay, 8 November 1950. The Mariner was returning to Iwakuni Bay, Japan from a Korean patrol. This version saw service throughout the Korean War, flying patrols along the Chinese and north Korean coastlines. The type was even considered for a daring operation which involved landing on a reservoir, but in the event this was thwarted by the frozen surface.

Left: JATO was installed as standard on the PBM-5. Its use helped counter the extra weight of new operational equipment.

Right: The greatest seaplane/flying boat operation in history was the March 1945 invasion of Okinawa, in which the PBM-5 was the main type used. This Mariner is seen on Saipan just before the operation.

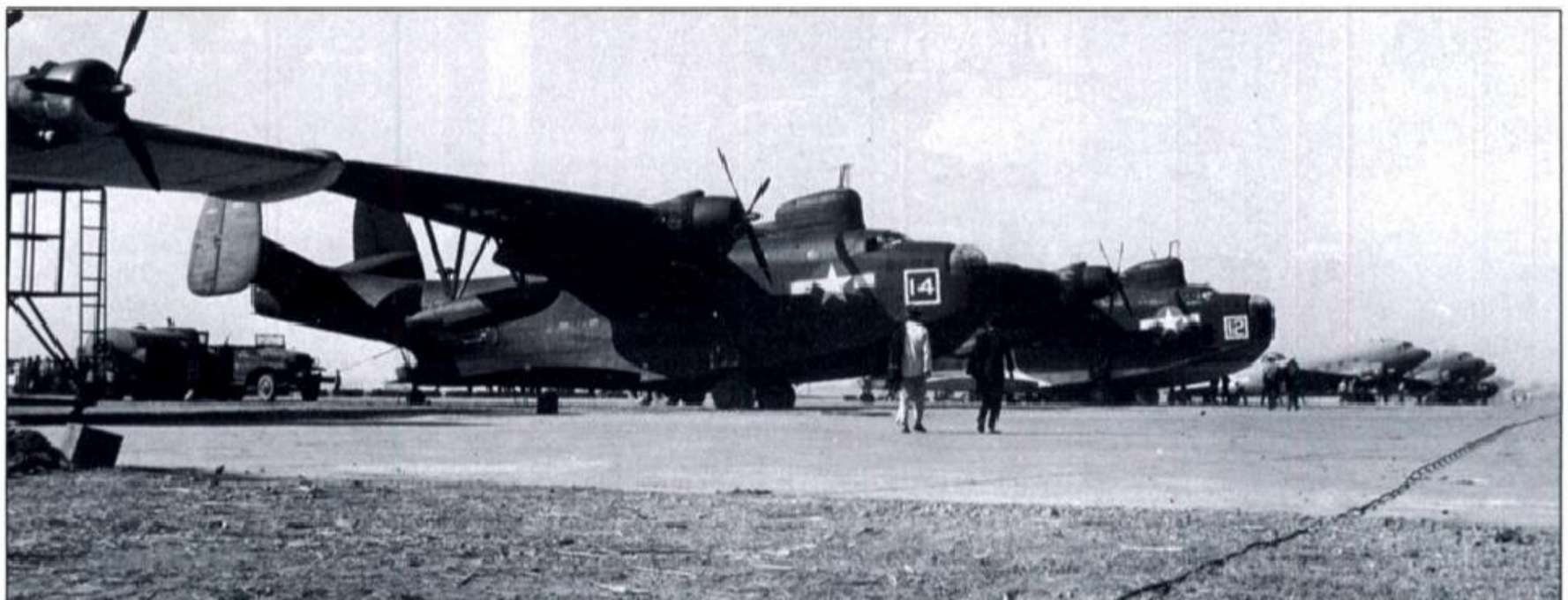
Left: This Korean War-era PBM-5 has the later four-bladed propellers in contrast to those on the aircraft above. The outhouse marking was a personal decoration.

Right: This view of a factory-fresh PBM-5 illustrates the characteristic gull wing and 'pinwheel' tail grouping of the Mariner. By 1944, the PBM was the mainstay of the VP squadrons in the Pacific theatre.

PBM-5E

The PBM-5E designation applies to some PBM-5 aircraft with AN/APS-15 radar and other electronic equipment. A number of the -5E aircraft were diverted to the US Coast Guard, which used them as non-flying sources of spare parts. A single PBM-5E was converted and designated PBM-5C for use in missile tests.

A pair of PBM-5Es is seen on a ramp together with PBYs and C-47s in China in 1945.



PBM-5A (Model 162G)

The final production Mariner, the PBM-5A, incorporated amphibious landing gear and operated from land and sea. The first wheeled Mariner was the XPBM-5A, BuNo. 59349. The US Navy had 40 PBM-5As, including 36 new-build aircraft and four converted at the factory. A PBM-5A was the 1,361st and last Mariner (BuNo. 122613), rolled out of the factory on 9 March 1949. The first PBM-5A was turned over to the Coast Guard for evaluation. On 18 November 1949, this aircraft (BuNo. 122067) crashed and was damaged beyond economical repair. The Coast Guard eventually refocused its interest in amphibious capability on the Grumman UF-1G Albatross.

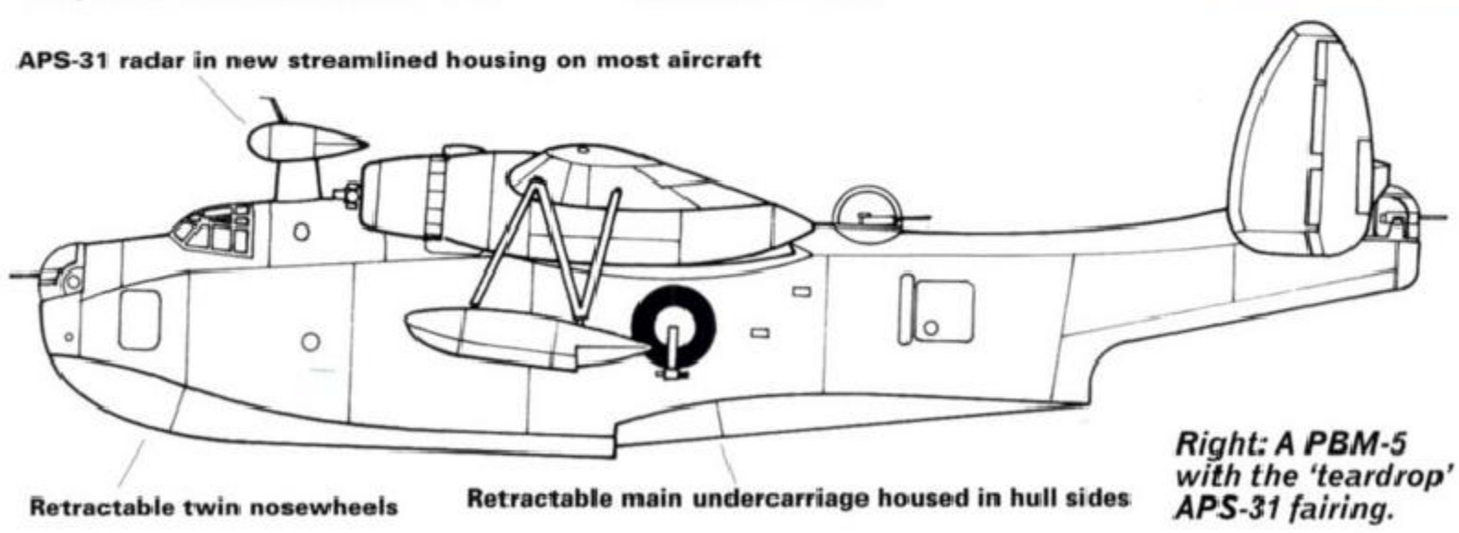
A PBM-5A is the only surviving Mariner today and is located at the Pima Air and Space Museum in Tucson, Arizona. Reports of a survivor in Uruguay are in error.

The Netherlands operated 17 PBM-5As with its No. 321 Squadron at Biak, Dutch New Guinea, in 1955-56.

BuNos 122067/122086, 122468/122471, 122602/122613 (36)

Above right: A PBM-5A takes off from a land base. The national insignia is of interest – this style, sans red stripe, was superseded 11 months before the XPBM-5A flew.

Right: This PBM-5A based at Oppama, Japan in 1952 sports an unusual tail enclosure. The -5A was the only amphibian of the series.


APS-31 radar in new streamlined housing on most aircraft
Retractable twin nosewheels
Retractable main undercarriage housed in hull sides

Right: A PBM-5 with the 'teardrop' APS-31 fairing.

PBM-5M

The PBM-5M, apparently an incorrect use of the of the 'M' suffix indicating a weapons improvement, was the designation for a Mariner used to monitor missile tests.

PBM-5N

The PBM-5N, using the 'N' suffix usually employed for night operations, was an all-weather version of the Mariner. One was flown.

BuNo. 98606

PBM-5S

The PBM-5S was a lightened anti-submarine warfare version of the Mariner. An unknown number were converted or redesignated from PBM-5s.

Below: A PBM-5S2 takes off with the aid of JATO at Jacksonville, 21 September 1955. Mariners were involved in several important post-war operations as well as sea patrol and mine clearing in the Korean War. They included Operation Crossroads, and Operation High Jump in Antarctic waters.

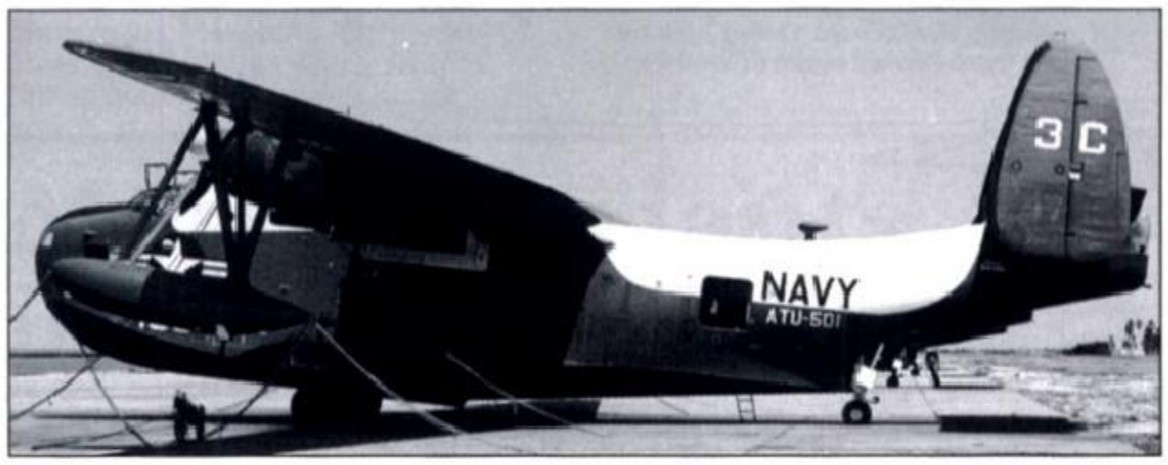
PBM-5S2

The PBM-5S2, which made one combat tour in Korea and served well into the 1950s, was distinguished externally from other flying-boat Mariners by a teardrop- or bullet-shaped radome mounted on a pedestal above and behind the flight deck. The PBM-5S2 employed a huge, 50-million candlepower searchlight. Three of these aircraft served with the Uruguayan navy.

Above: This view of a VP-74 PBM-5S2 at Jacksonville shows the searchlight mounted under the starboard wing of this model.

Below: A-811, one of three Uruguayan navy PBM-5S2s, is seen in July 1963. The badge depicts a grasshopper or cricket landing on water.

Below: Solar-reflecting white top surfaces appeared on some PBMs used for training, including those of Advanced Training Unit 501.



PBM-5G

Twenty-four standard PBM-5s carried out search and rescue duties with the Coast Guard under the designation PBM-5G (the 'G' suffix was added to these aircraft, but not to numerous others, after they were received from the Navy). The service apparently received a total of 41 of all 'dash five' sub-variants, although one reliable source puts the figure at 49 including one PBM-5A and many PBM-5Es used for parts. In post-war years these aircraft were in natural metal with black-bordered yellow marking stripes. Widely employed for coastal SAR and maritime enforcement

In natural metal finish, a Coast Guard PBM-5G makes a JATO take off from its base at Salem, Massachusetts, 10 May 1948.

work, often on flights that routinely employed JATO, the Mariner was eventually replaced in Coast Guard colours by the P5M Marlin. The last flight by a Coast Guard Mariner occurred on 22 April 1958 when Lieutenant Commander John 'Muddy' Waters piloted BuNo. 59148 from Coast Guard Air Station San Diego on a local flight to Pt Loma.

The US Coast Guard was the last American user of the PBM. There was no appreciable civil market for the type as there was for the PBY Catalina, the majority of which were amphibians. Some PBMs entered the US civil register as live lobster freighters.

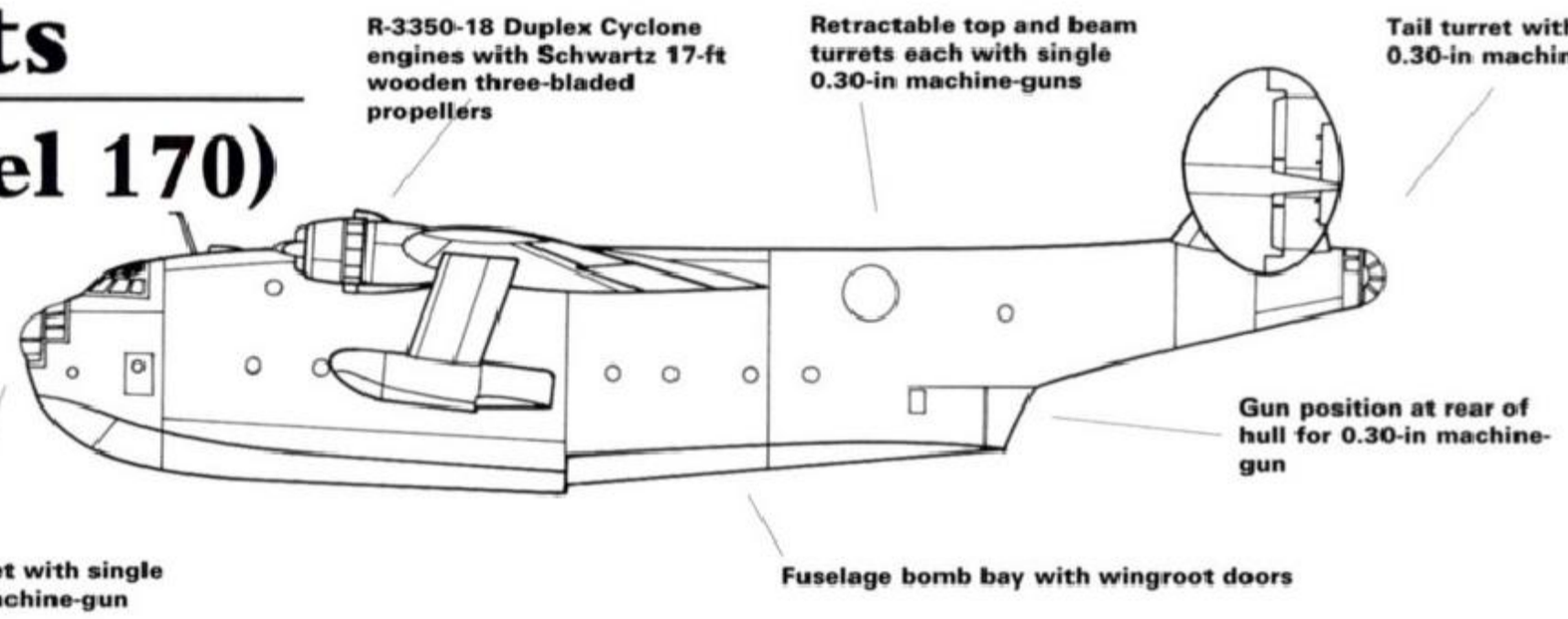
XPBM-6

The designation XPBM-6 reportedly applied to an early Martin concept for the enlarged, single-tail, one-step hull aircraft based on the Mariner that eventually became the P5M Marlin. The XPBM-6 concept apparently would have resembled the Marlin but with shorter fuselage and vertical tail. Although one published source contains the cryptic assertion that a single PBM-3D (BuNo. 45274) was modified and delivered under the designation XPBM-6, there appear to be no surviving records on this aircraft and no indicating that it was, in fact, built with a hull and tail different from that of the production Mariner.

Mars Variants

XPB2M-1 (Model 170)

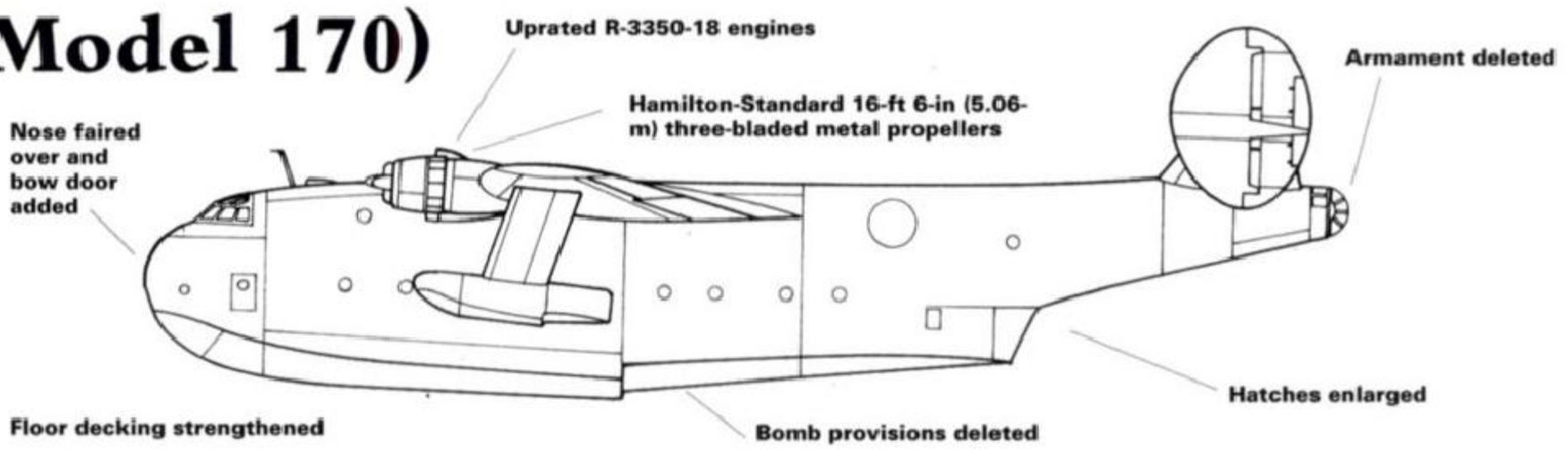
The silvery Martin Mars prototype was conceived as a maritime patrol bomber. It was easily recognised by its twin tail, the only aircraft in the Mars series with a double empennage. The XPB2M-1 had provision for turrets but no internal armour. It was powered by four Curtiss Wright R-3350-8 Duplex engines developing 2,250 hp (1680 kW) with reversing 16-ft 8-in (5.07-m) propellers, and had an operational gross weight up to 145,000 lb (65770 kg). The XPB2M-1 completed its maiden flight on 3 July 1942. It was eventually painted in standard Navy blue and grey.
BuNo. 1520


R-3350-18 Duplex Cyclone engines with Schwartz 17-ft wooden three-bladed propellers
Retractable top and beam turrets each with single 0.30-in machine-guns
Tail turret with single 0.30-in machine-gun
Gun position at rear of hull for 0.30-in machine-gun
Nose turret with single 0.30-in machine-gun
Fuselage bomb bay with wingroot doors

Left and below: At the time of its roll-out, the XPB2M-1 was the world's largest aircraft, with a span of exactly 200 ft (60.96 m). The slightly bizarre publicity photo at left shows a Taylorcraft atop the Mars for scale. The view, below, of the aircraft's christening ceremony at Frog Mortar Creek illustrates why Martin regarded the Mars as a 'Sky Battleship'.

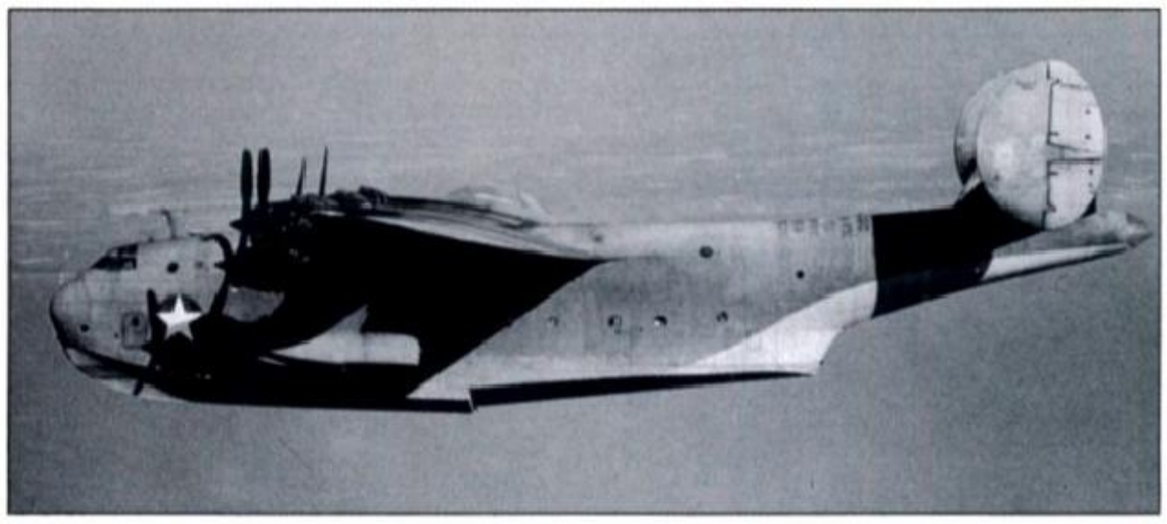
XPB2M-1R (Model 170)

The XP2M-1R designation was applied to the twin-tailed Mars prototype in its capacity as a transport ('R' suffix). Martin engineers stripped the aircraft of its bombing equipment and armament. As a transport, this aircraft achieved many records including the long-distance flights cited in the introduction.

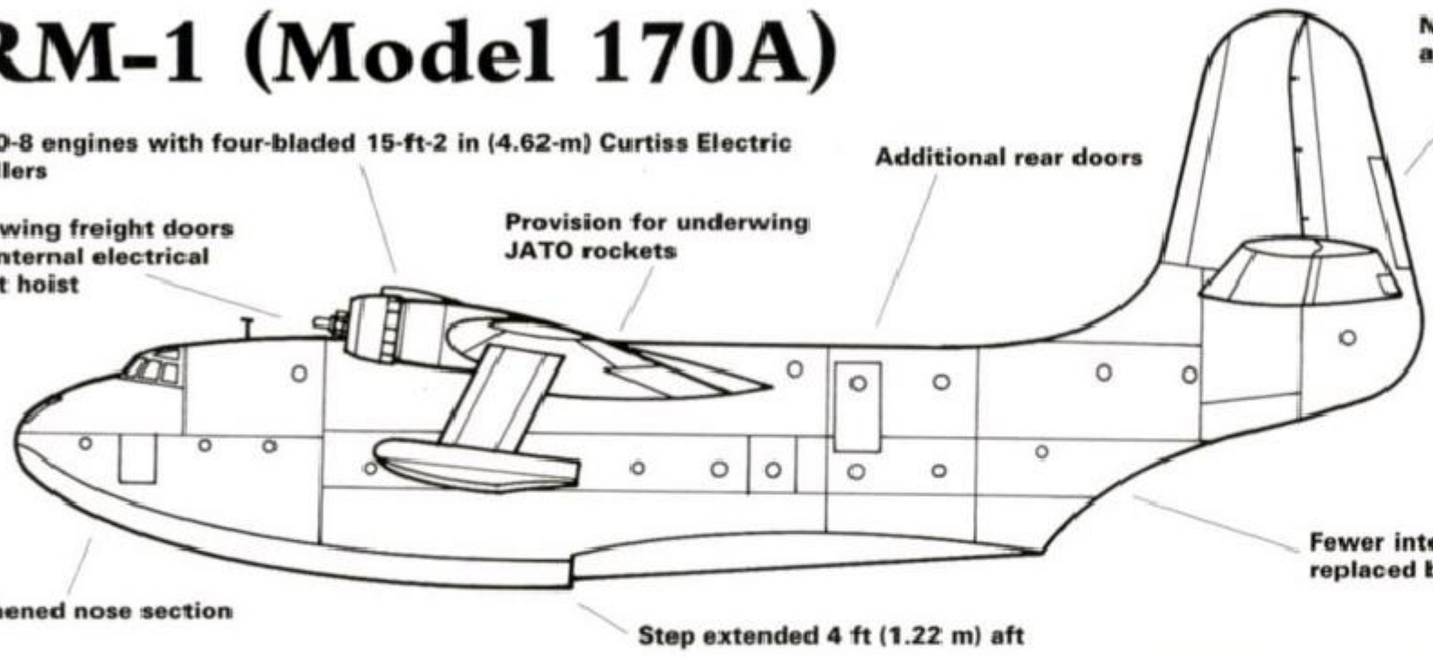


Left: After passing Navy acceptance tests, the Mars was returned to Martin for conversion to a freighter. In November 1943, the XPB2M-1R joined VR-8 of NATS at Alameda, near San Francisco.

Right: The XPB2M-1R wore camouflage for about a year before reverting to natural metal. It broke numerous records carrying freight and personnel on the San Francisco-Hawaii route .



JRM-1 (Model 170A)


R-3350-8 engines with four-bladed 15-ft-2 in (4.62-m) Curtiss Electric propellers
Underwing freight doors with internal electrical freight hoist
Provision for underwing JATO rockets
Additional rear doors
New single fin and tailplane
Fewer internal bulkheads, replaced by frames
Lengthened nose section
Step extended 4 ft (1.22 m) aft

The JRM-1 designation went to the initial configuration of the first five aircraft in the JRM series developed from the outset as Mars transports. The JRM was a complete redesign of the Mars concept, easily distinguished by its prominent 44-ft (13.41-m) single fin replacing the double tail of the PB2M. The hull of the JRM was 6 ft (1.82 m) longer than that of the PB2M. Internally, the JRM had fewer bulkheads, hence a more open 'feel' in its passenger and cargo areas. The JRM-1 powerplant was the 2,250-hp (1680-kW) Wright R-3350-8.

In 1944, the Navy ordered 20 aircraft to be built from the outset as transports, designated JRM-1 and able to carry up to 301 fully-armed troops. With the end of the war, total production was five JRM-1s and one JRM-2, all delivered after VJ-Day. Each JRM was named for a Pacific island. The *Hawaii Mars* (BuNo. 76819) crashed in the Chesapeake Bay during early flight tests on 5 August 1945. Other 'dash one' aircraft were the *Philippine Mars* (76820), *Marianas Mars* (76821), *Marshall Mars* (76822), and the second *Hawaii Mars* (76823). All were assigned to VR-2.

BuNos 76819/76823 (5)

The **Marshall Mars** *was the first JRM-1 to join VR-2 in 1946. It carried a record-breaking 308 people on one flight in May 1949.*

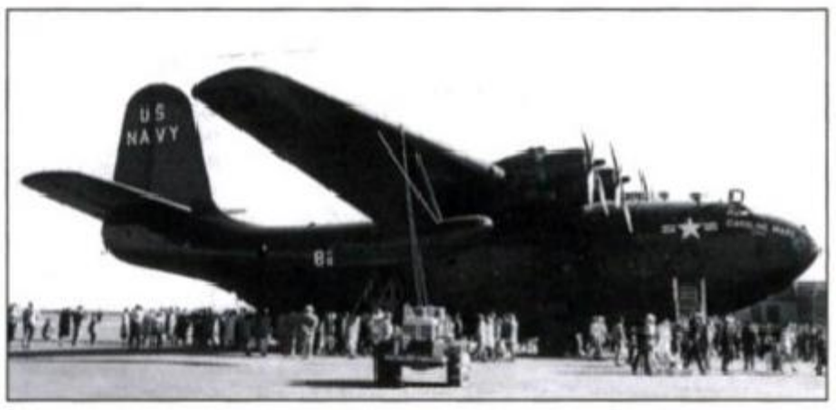
Below: The Mars had problems with engine fires.* Philippine Mars *had an engine burn and fall off in flight.

JRM-2 (Model 170B)

The sole JRM-2 was the *Caroline Mars* (BuNo. 76824), powered by 3,000-hp (2240-kW) Pratt & Whitney R-4360-4 Wasp Major 28-cylinder 'corn cob' engines. This aircraft was rated for 165,000 lb (74845 kg) but could actually fly at 176,000 lb (79832 kg). It was lost in a hurricane in 1962.

BuNo. 76824

The JRM-2's new engines required new 16-ft 8-in (5.68-m) Curtiss-Electric propellers, of which the inner pair was reversible.



Above: The* Caroline Mars *is seen on display circa 1948. The fuselage code is '824'. Later, the 'RA' tail code of VR-2 was applied.

JRM-3 (Model 170B)

The JRM-3 designation went to the JRM-2 and the three surviving JRM-1 aircraft when they were re-engined with R-4360 Wasp Majors.

BuNos 76820/76823

The four Mars in service with VR-2 until 1956 are seen here.* Philippine Mars *leads* Marianas Mars, Hawaii Mars *and* Caroline Mars. *In 1959, the aircraft were sold as scrap.

The four Mars were bought by Forest Industries Flying Tankers for use as fire-bombers. Two were lost –* Marianas Mars *in a 1960 crash and* Caroline Mars *in Hurricane Frieda – but* Hawaii Mars *(seen here) and* Philippine Mars *are in service today at Sproat Lake, British Columbia.

Marlin Variants

P4M-1 (Model 225)

The designation P4M-1 was established for a planned Martin-built aircraft developed from the Boeing XPBB-1 Sea Ranger but powered by the colossal 3,000-hp (2640-kW) Pratt & Whitney R-4360-4 Wasp Major 28-row 'corn cob' engines. The R-4360-4 was the biggest, most complex American powerplant of its kind and was the power source for the JRM-2 and -3 Mars.

The Boeing XPBB-1 was powered by two 2,000-hp (1490-kW) Wright R-3350-8s, had a crew of 10, and a gross weight of 101,129 lb (45872 kg). It was the largest twin-engined aircraft ever built in the United States at the time of its first flight on 9 July 1942. Plans for Boeing to manufacture 57 PBB-1s at Renton, Washington conflicted with the higher-priority B-29 Superfortress bomber which needed both the factory and the -3350 engines. When separate hopes for a successful large flying-boat ended with cancellation of the PBM-4 Mariner, the Navy planned to manufacture the Sea Ranger with different engines at Martin's Baltimore plant. The sole XPBB-1 Ranger flew from Washington state to Patuxent River, Maryland, where Glenn L. Martin engineers working on the projected P4M-1 had access to it. The Martin-built Sea Ranger was subsequently abandoned, and the P4M-1 designation was later reissued for the land-based Model 219 Mercator patrol aircraft.

XP5M-1 (Model 237)

The XP5M-1 Marlin was the prototype for the Cold War-era Marlin series and was constructed from an aircraft that began on the production line as the final PBM-5 Mariner. This prototype was powered by two Wright R-3350-26Ws. The aircraft looked like an enlarged Mariner with a slightly modified nose, a new hull, and a wholly different tail. It retained the 118-ft (35.96-m) Mariner wing and floats (while an evaluation of several new float designs was pending). The prototype's afterbody was lengthened 11 ft (3.35 m), increasing fuselage length from the 79 ft 10 in (24.32 m) of the PBM-5 to 90 ft 10 in (27.67 m). A recognition feature of this aircraft was the pedestal-mounted radome associated with the PBM-5S2 ASW Mariner.

The XP5M-1 introduced the tall, single tail that was to be a distinctive feature of the Marlin, with the low-mounted horizontal stabiliser that characterised the P5M-1 series. The single tail made this aircraft 20 per cent taller, so that the 28 ft 10 in (8.77 m) of the P5M-1 increased to 36 ft 7 in (11.15 m). At a gross weight of 60,000 lb (27215 kg), the Marlin prototype was substantially lighter than production machines which followed.

Key to the Marlin design was an efficient, single-step 'Vee' hull with lengthened afterbody and greater length-to-beam ratio

Mariner, Mars and Marlin Variants

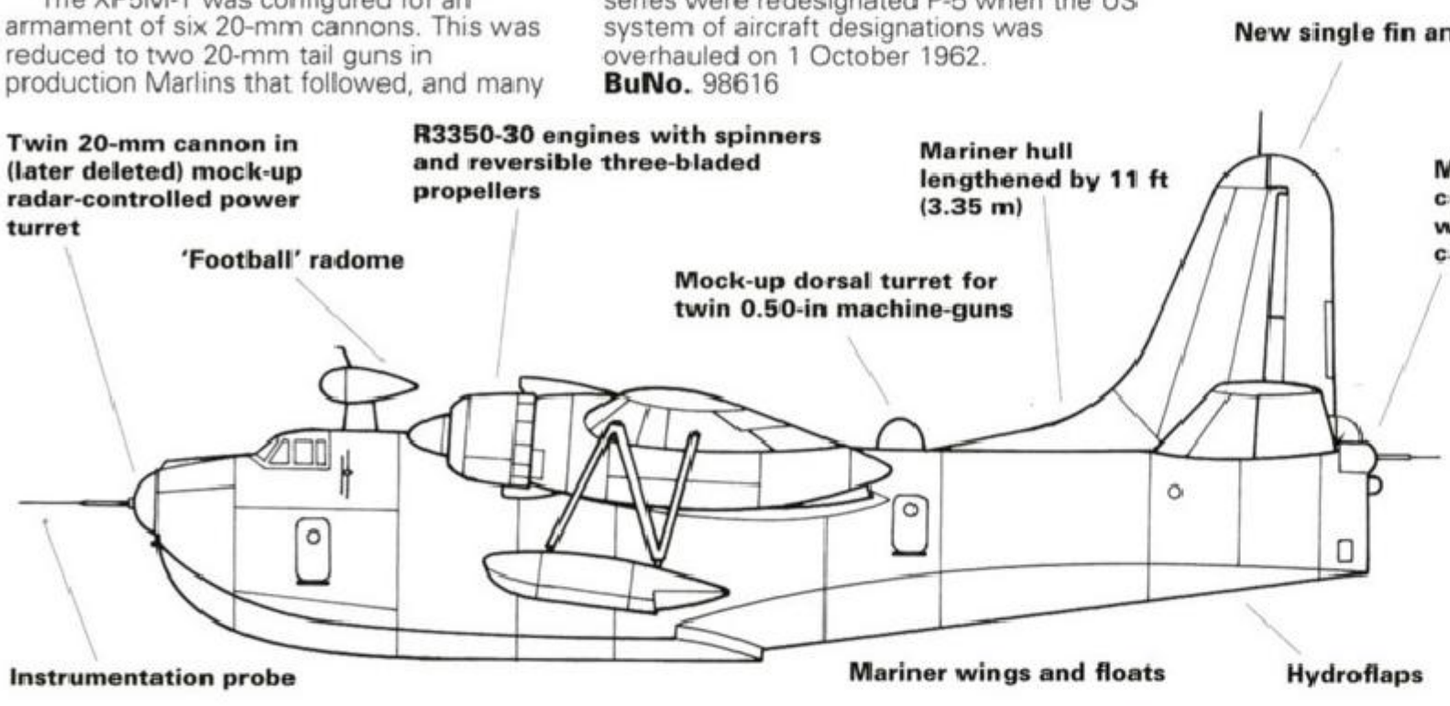
(8.5 to 1), intended to free the Marlin from the porpoising tendency that had plagued the early Mariner. The aircraft introduced the Marlin series' hydroflaps, which were used to improve turn radius and general manoeuvrability in the water and were operated by the pilot using a step on the rudder pedals.

The XP5M-1 was configured for an armament of six 20-mm cannons. This was reduced to two 20-mm tail guns in production Marlins that followed, and many of these had their armament removed as the Marlin's career progressed.

On 30 May 1948, Martin test pilots O. E. 'Pat' Tibbs and Wilbur Smith took the XP5M-1 on its first flight. This prototype for the Marlin series was later modified to become the sole Model 270 (US Navy M-270) test aircraft. All aircraft in the P5M series were redesignated P-5 when the US system of aircraft designations was overhauled on 1 October 1962.

BuNo. 98616

The XP5M-1 tested the configuration and new features, such as the hydroflaps, intended for the Marlin, but was built mainly with Mariner components.


Twin 20-mm cannon in (later deleted) mock-up radar-controlled power turret
'Football' radome
R3350-30 engines with spinners and reversible three-bladed propellers
Mariner hull lengthened by 11 ft (3.35 m)
Mock-up dorsal turret for twin 0.50-in machine-guns
New single fin and rudder
Mock-up radar-controlled power turret with twin 20-mm cannon
Instrumentation probe
Mariner wings and floats
Hydroflaps

Below: The most important change to the Mariner was the long afterbody hull which allowed much safer landings in rough water.

P5M-1 (Model 237A) (P-5A)

The P5M-1, the initial production Marlin, was powered by refined Wright R-3350-30WA Turbo-Compound engines rated at 3,250 hp (2424 kW) each. The gloss-blue aircraft could be boosted aloft by four jettisonable JATO (jet-assisted take-off) rocket bottles. Large engine nacelles housed bomb bays on the underside of the centre wing. The Marlin could carry up to 8,000 lb (3630 kg) of weapons including bombs, depth charges and torpedoes. There was no weapons bay in the fuselage. Martin's hydroflaps became a standard feature on production aircraft. All of the 'dash one' aircraft had a low-mounted horizontal tailplane.

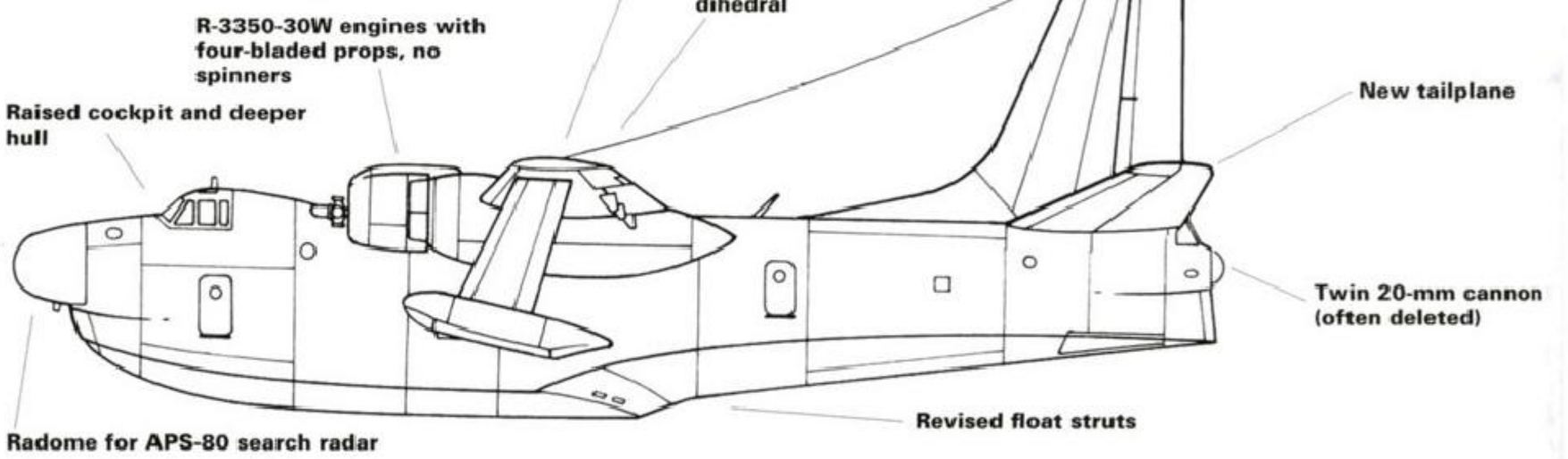
Weighing 73,000 lb (33110 kg) when fully loaded, the P5M-1 had dimensions slightly different from the XP5M-1 prototype: wingspan was reduced from 90 ft 10 in (27.67 m) to 90 ft 3 in (27.50 m) and height from 36 ft 7 in (11.15 m) to 35 ft 2 in (10.72 m).

The P5M-1 was armed with twin 20-mm cannons in an Aero 11D-1 powered turret in the tail. The tail gunner aimed and fired them remotely, sighting through a Mk 18 Model 7 lead-computing gunsight in a domed Plexiglass window just above the turret.

Martin's Pat Tibbs made the first flight of a production P5M-1 Marlin on 21 June 1951. Manufacture of this variant totalled 160 aircraft. The P5M-1 Marlin gradually replaced the PBM-5 Mariner in Navy patrol squadrons. Eventually, surviving P5M-1 aircraft were upgraded to P5M-1S standard to improve their ASW capability.

One aircraft in this series (BuNo. 130286) was modified to evaluate the T-tail arrangement chosen for the P5M-2 model, and first flew with the new tail in August 1953.

BuNos 124910/124914, 126490/126511, 127696/127719, 130265/130351, 135452/135473 (160)


Droppable bomb bay fuel tanks
MAD sensor sometimes fitted
Increased wing dihedral
R-3350-30W engines with four-bladed props, no spinners
Raised cockpit and deeper hull
New tailplane
Twin 20-mm cannon (often deleted)
Revised float struts
Radome for APS-80 search radar

This 24 July 1952 view shows an early P5M-1 undergoing trials at the Naval Air Test Center at Patuxent River. Poor engine accessibility was a fact of life with flying-boats.

Above: Improvements in Soviet submarines led a to a reduction in gun armament on the P5M-1 and more emphasis on technology such as radar and sonobuoys.

P5M-1S (Model 237A) (SP-5A)

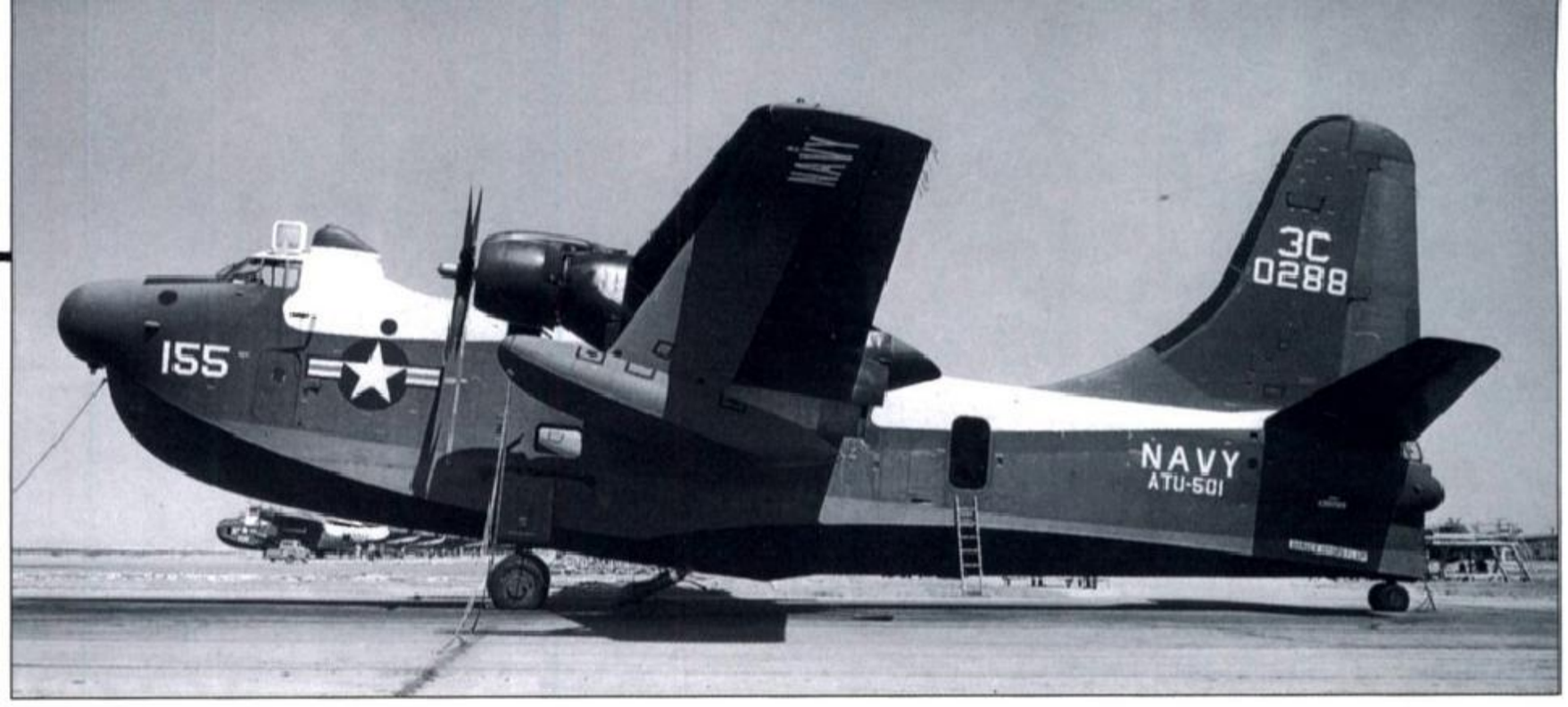
The P5M-1S (along with the P5M-2S) was the redesignated Marlin that resulted from an exhaustive 1957-59 modification programme carried out by Marlin in its Baltimore factory and aimed at greatly enhancing the Marlin's ASW capability. The programme included installation of AN/APA-69A direction-finding equipment, recognised by a 'doghouse' enclosure atop the cockpit, and the AN/ASQ-8 magnetic anomaly detector (MAD) mounted in a fairing that protruded back from the tip of the vertical stabiliser. The Julie/Jezebel ASW suite and Aircraft Integrated Display System were installed, both developed by the Naval Air Development Center at Johnsville, Pennsylvania (near Philadelphia) and aimed at improving detection and localisation of submarines.

The Julie ECM (Electronic Counter Measures) suite was named for Julie Gibson, a stripper in Philadelphia, and was an explosive echo-ranging and localisation system that employed a two-pen, paper-traced ASA-20 recorder at the operator's station. This produced range data that was fed into a computer (part of the AIDS system) which computed the actual target location and distance. Jezebel was a search-detection system that used sonobuoys for primary search, detection and classification of underwater targets. An ARR-858 receiver group and an AQA-3 indicator group at an operator's position on the flight deck collected and analysed the sonar data. The operation of the new ASW

system was the duty of a tactical co-ordinator, who orchestrated the search and attack. This new crew member was a navigator, known in later years as a Naval Flight Officer (NFO).

P5M-1S and P5M-2S Marlins dispensed with their tail gun armament, and in place of the cannons an AN/APN-122 warning antenna was installed. The P5M-1S retained the low-mounted horizontal tail that was an identifying feature of the 'dash one' series.

The P5M-1S was the first Marlin with the 'doghouse' fairing for DF equipment above the cockpit.



P5M-1G (Model 237A)

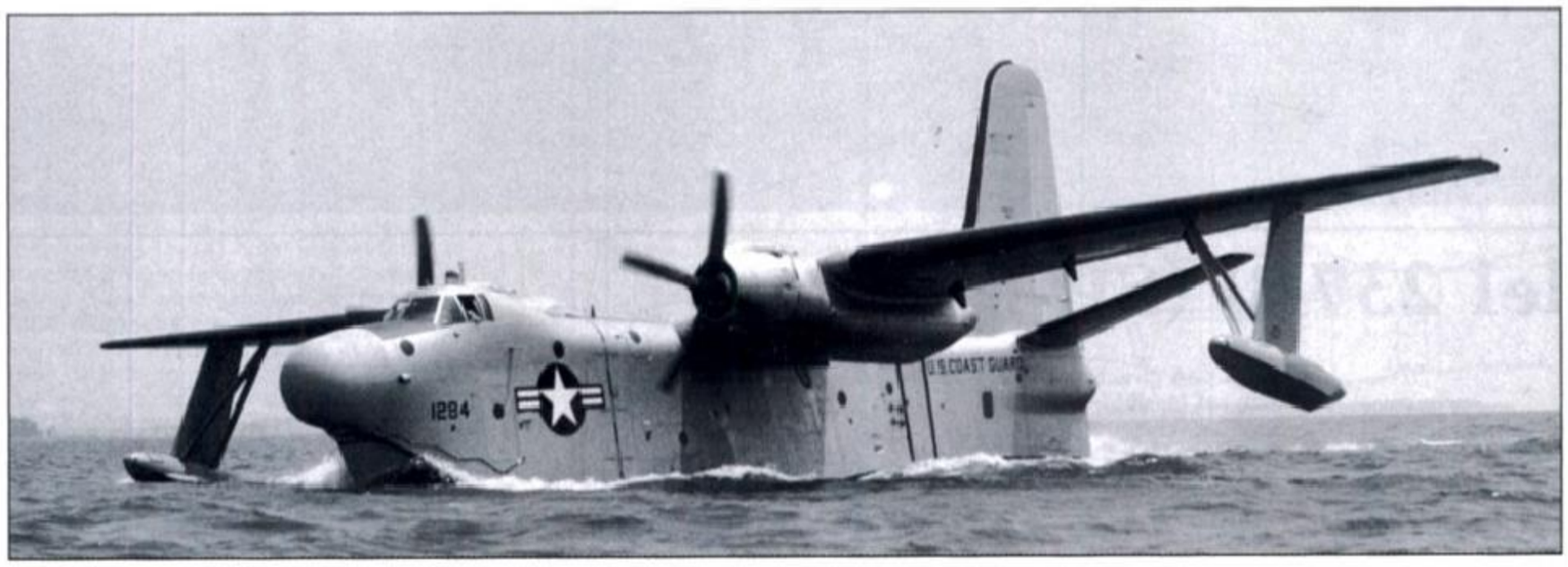
The P5M-1G was the first US Coast Guard version of the Marlin, ordered initially in 1953 partly as a replacement for the Grumman UF-1G Albatross. The seven P5M-1Gs were optimised for air-sea rescue duties and were devoid of the ASW equipment and defensive armament found on Navy Mariners. The P5M-1G retained the low-mounted horizontal tail.

The first P5M-1G left the Martin factory in October 1953 and was deemed operational in February 1954. When the Coast Guard had an opportunity to acquire low-time Grumman SA-16 Albatross seaplanes from the US Air Force in 1960, it decided to reduce operating costs and transfer its Marlins to the Navy. All seven P5M-1Gs completed Coast Guard duty and were returned to the Navy, which belatedly assigned Bureau numbers to them and operated them, still without weaponry, as P5M-1T trainers.

serial numbers 1284/1287, 1295/1297 (7)

Below: The first of the P5M-1Gs for the Coast Guard is seen riding the swells. This aircraft was based at Elizabeth City, North Carolina.

P5M-1Gs were equipped for open water operations, with reversible propellers and JATO. USN 'boats were rarely landed on the high seas.



P5M-1T (Model 237A) (TP-5A)

The P5M-1T designation went to the Coast Guard P5M-1Gs upon their transfer to the Navy in 1960. They were still characterised by the low-mounted horizontal tail, lacked combat equipment or armament, and wore a high-visibility Coast Guard paint scheme. These aircraft had not previously served in the Navy and had to be assigned new Bureau numbers. An identical transfer was made of T-tailed P5M-2G flying-boats, which became P5M-2Ts.
BuNos 149825/149831

P5M-2 (Model 237B) (P-5B)

The P5M-2 Marlin, the second major production version, introduced a distinctive T-tail deemed most efficient for reduced weight and spray characteristics over the control surfaces. The P5M-2 also differed in having its bow chine line lowered to reduce spray height during landing and take-off, thus eliminating excessive spray from propeller and flap areas. Redesign of the tail was based on P5M-1 experience, while redesign of the bow chine resulted from tests with the M-270 research aircraft. The P5M-2 was powered by 3,450-hp (2575-kW) R-3350-32WA engines, which gave this aircraft a slightly higher speed than the P5M-1 of 276 mph (444 km/h).

The first production P5M-2 (BuNo. 135745) made its first official flight on 29 April 1954 and reached the Navy two months later. Squadron VP-47 at NAS Alameda, California began to receive operational P5M-2s on 18 October 1954. Ten P5M-2s were delivered to France, the only overseas user of the Marlin. They were assigned to the Aéronavale's 27 Flottille based at Dakar, Senegal and were employed in exhausting patrols of up to 14 hours in the tropical African heat.

Apart from an unchanged wingspan, dimensions of the P5M-2 were slightly different than those of the P5M-1. Length was increased to 100 ft 2 in (35.56 m) while height was reduced to 30 ft 11 in (9.42 m). Gross weight went up to about 78,000 lb (35380 kg) and ordnance capacity rose to 10,000 lb (4536 kg).
BuNos 135474/135543, 137846/137848, 140140/140150, 141252/141258, 147926/147937; France: 146440/146445, 147539/147542 (115)

The T-tail introduced on the P5M-2 can be seen here as can the tail armament and the MAD equipment. Not visible here is the bluffer chine that reduced spray.

Right: A view of an Aéronavale P5M-2 in the markings of the sole French user, 27F. These aircraft were provided under MAP and were returned to the US upon retirement.

Above: P5M-2s of VP-42 are seen near Sangley Point in the Philippines in June 1956. Marlins operated from here for another decade.

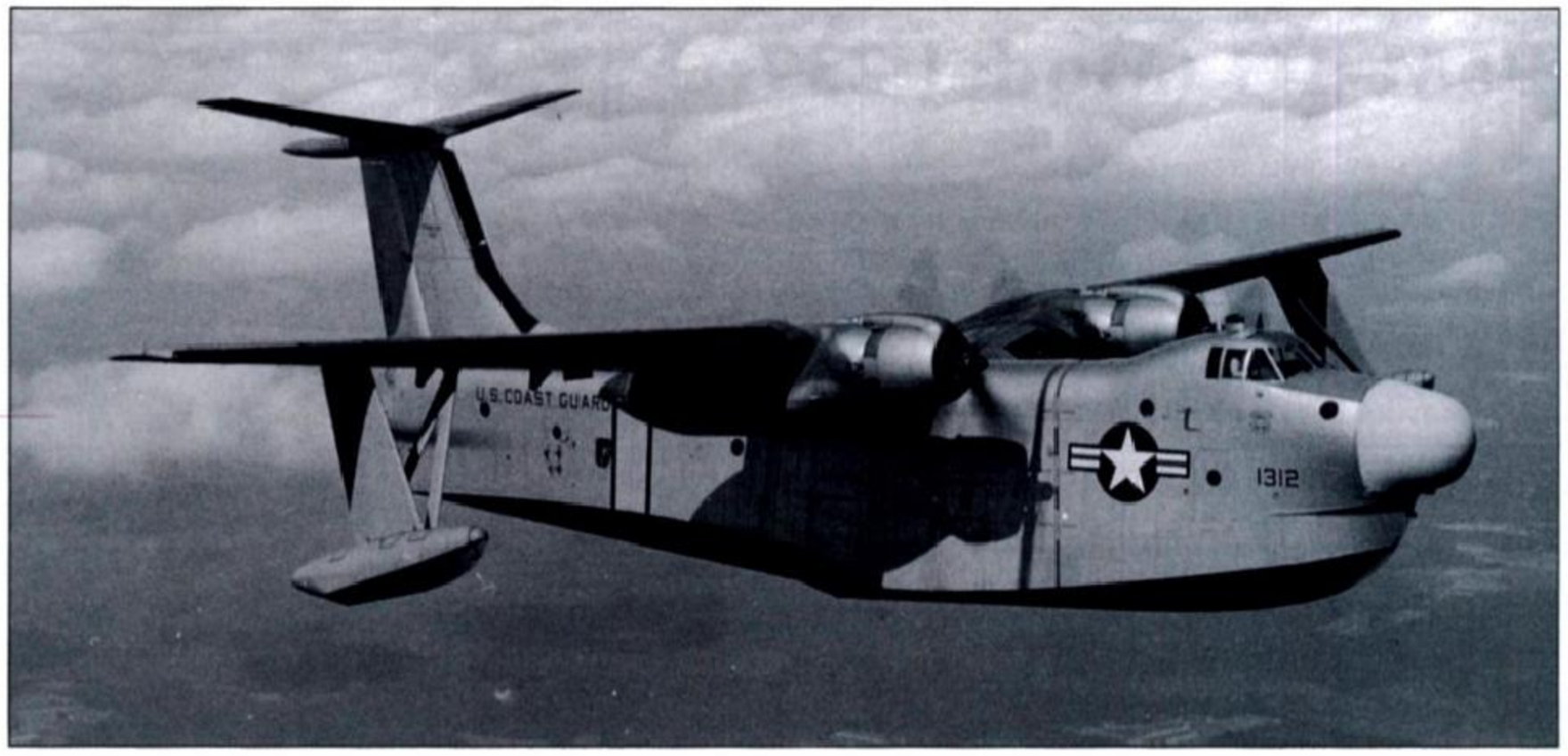
This Philippines-based P5M-2 wears the 'E' for efficiency symbol. Formerly awarded by Bureau of Aeronautics, from 1952 it became the prerogative of the fleet commanders. Often, as here, extra letters were added to denote proficiency in bombing ('B'), gunnery ('G'), rocketry ('R') and anti-submarine ('S') skills.

P5M-2G (Model 237V)

The US Coast Guard took delivery of four new-build P5M-2G aircraft, minus ASW equipment, for search and rescue duties. These aircraft had the T-tail of the 'dash two' series, lacked weapons, and raised the Coast Guard's total Marlin fleet to 11 aircraft. The Coast Guard operated -1G and -2G models virtually interchangeably at stations in Elizabeth City, NC, St Petersburg, FL, San Francisco, CA and San Diego, CA. When the Coast Guard acquired several low-time Grumman SA-16 Albatross seaplanes from the US Air Force in 1960, it transferred its Marlins to the Navy. The P5M-2Gs, when returned to the Navy, became P5M-2Ts.

BuNos 1312, 1318/1320 (4)

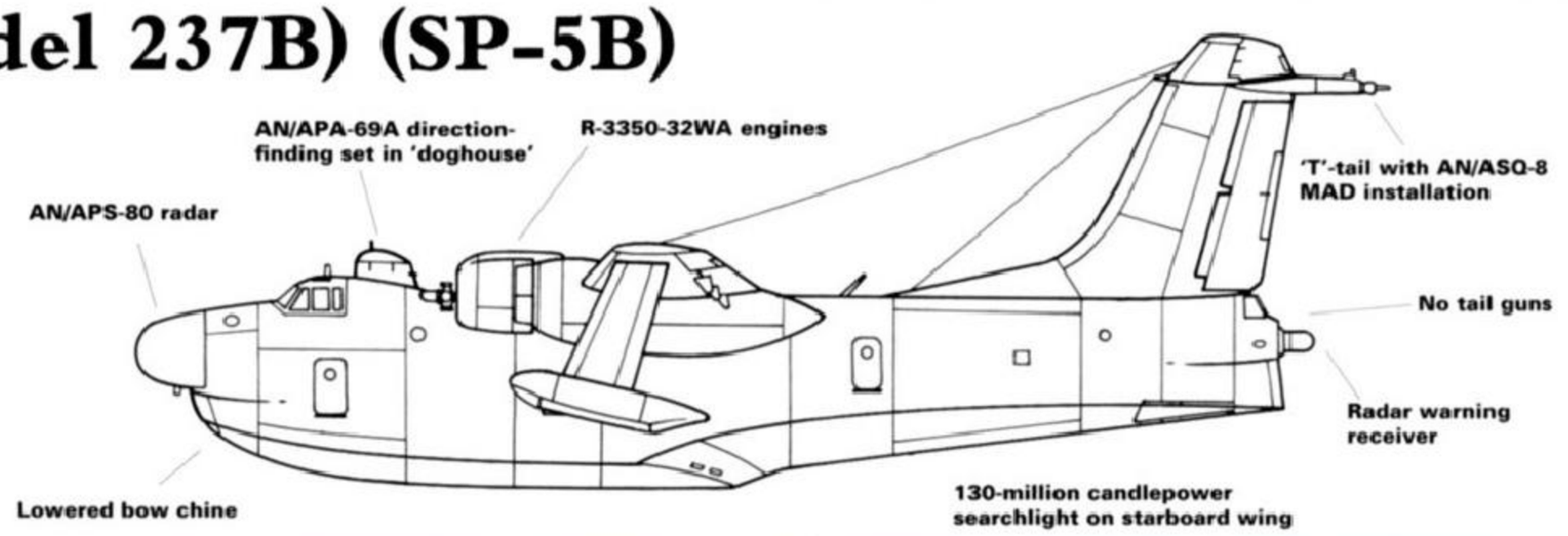
The first of the Coast Guard's four T-tailed P5M-2Gs is seen here. Accepted in February 1956, its first station was Elizabeth City.



P5M-2S (Model 237B) (SP-5B)

The P5M-2S with Julie/Jezebel, and the AIDS-equipped P5M-2S (SP-5B), was the ultimate propeller-driven, ASW flying-boat. One of these was tested late in its career with jet power added. On 4 August 1964, the day of the Gulf of Tonkin incident which began the US build-up in Vietnam, the Bureau of Naval Weapons announced a contract to Martin to install a jet engine in the tail of one SP-5B Marlin. At this juncture, 55 SP-5Bs remained in service and the plan was to upgrade the Marlin fleet with J85 powerplants. In the meantime, one aircraft (BuNo. 141258) was fitted with a 3,000-lb (13.35-kN) thrust Pratt & Whitney J60-P-3 turbojet, the powerplant of the North American T-39 Sabreliner. At Patuxent, the ship was fitted with an unusual arrangement – found elsewhere only on helicopters – in which the air intake for the J60 faced backward.

Performance tests with the J60-boosted SP-5B (which never had a special designation) were carried out in 1964-65. The aircraft was subsequently fitted with a 2,850-lb (12.67-kN) thrust General Electric J85-GE-17 turbojet, the powerplant used by the Cessna A-37B Dragonfly. It is unclear whether the Marlin flew with the latter, for by this time other priorities beckoned, and the US Navy decided to retire its patrol boat fleet.



The searchlight and all the principal antennas can be seen on this SP-5B. Note the misaligned tail number.

Left: A 1964 view of a VP-47 SP-5B 'on the step' near Whidbey Island.

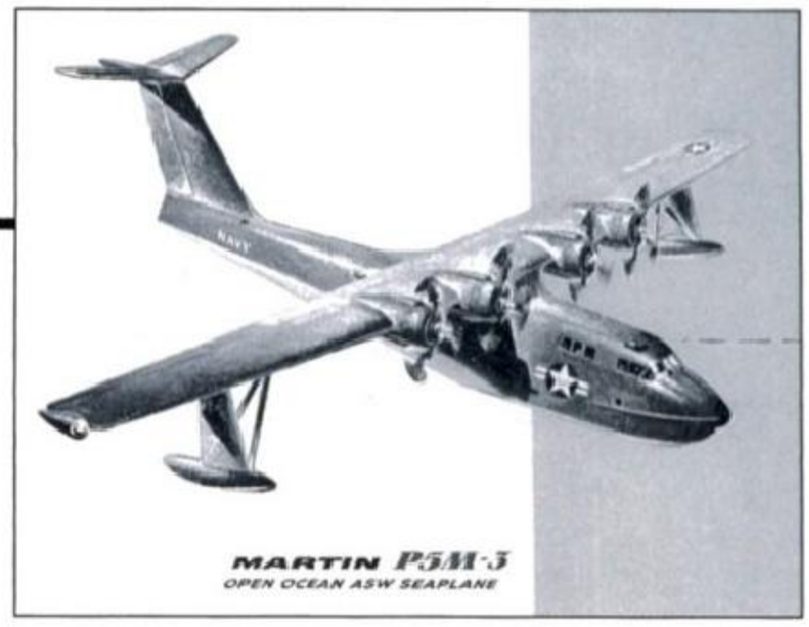
Right: An SP-5B of VP-40, the last USN flying-boat squadron is seen on a Market Time patrol over the Mekong Delta, looking for boats hidden in the undergrowth.

P5M-3 (Model 313)

The P5M-3 designation was applied in early 1955 to a proposed Martin flying-boat. From the start, the P5M-3 proposal was for a four-engined aircraft powered by four Wright R-1820-82 radial piston engines, with advanced ASW equipment and weapons, improved beaching capabilities, and comfortable crew accommodation.

Design work had begun on 12 October 1954 by engineering staff under Martin's P. Bercler. From its inception on the drawing board, it was in every respect a new aircraft rather than a third major version of the Marlin. Only weeks into the life of the project, it was designated P7M-1 (below).

The P5M-3 design bore only a passing resemblance to the Marlin. The fuselage more closely resembled Martin's contemporary jet-powered P6M Seamaster. Note the searchlight faired into the wingtip.



P7M-1 (Model 313)

The P7M-1 Submaster proposal, known in early conceptual stages as the P5M-3, was a futuristic jet-prop flying-boat with which the Navy decided not to proceed. The four-engined, propeller-driven seaplane was powered by 2,800-hp (3755-kW) Wright R-1820-82 Cyclone radials and a single XJ85 turbojet atop the wing for boundary layer control (BLC). The aircraft had a T-tail similar to the Marlin's, and non-retractable floats.

Designers omitted Marlin-style hydroflaps from the P7M-1, instead relying for water manoeuvrability on ducted air from the BLC system on each side of the lower fuselage. The P7M-1 Submaster was to have a crew of six: pilot, co-pilot, navigator-tactical co-ordinator, two ASW operators, and an aircraft captain.

In 1956, Martin reached the full-scale mock-up stage with the P7M-1. The aluminium and wood engineering mock-up was realistic on both exterior and interior, and included representative crew stations. The P7M-1 lost a competition against the proposed Consolidated P6Y-1 flying-boat; although the latter won and progressed much farther than the Martin design, it was never built.

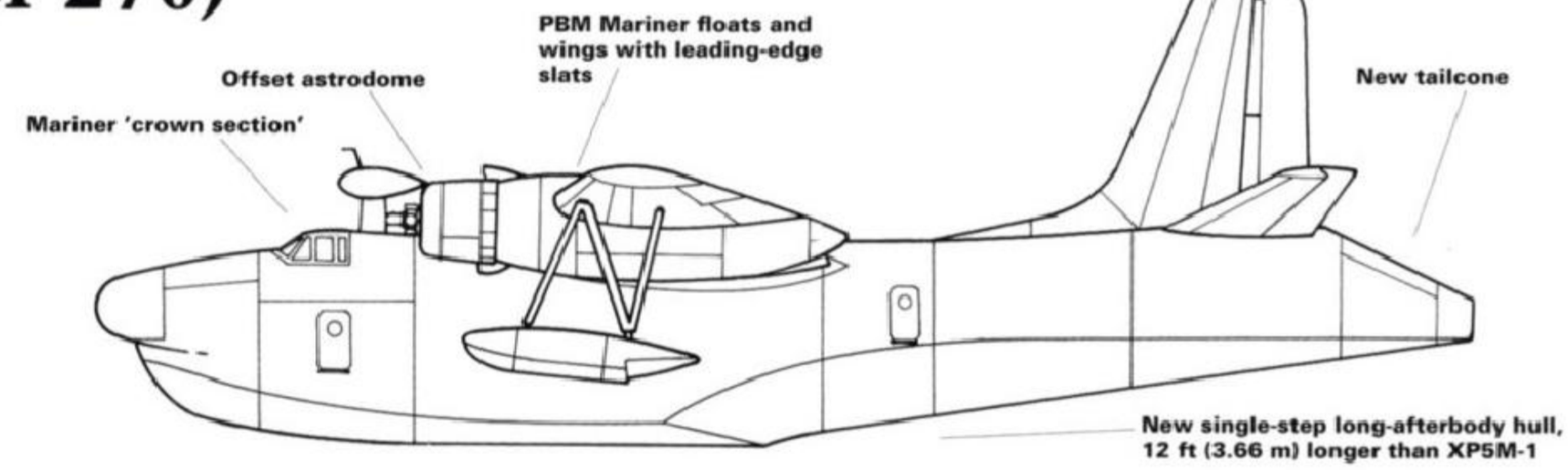
The P7M Submaster, which reached the mock-up stage, had a jet engine for BLC but relied on pistons for power. Proposed armament included a battery of Mighty Mouse rockets in the nose.

M-270 (Model 270)

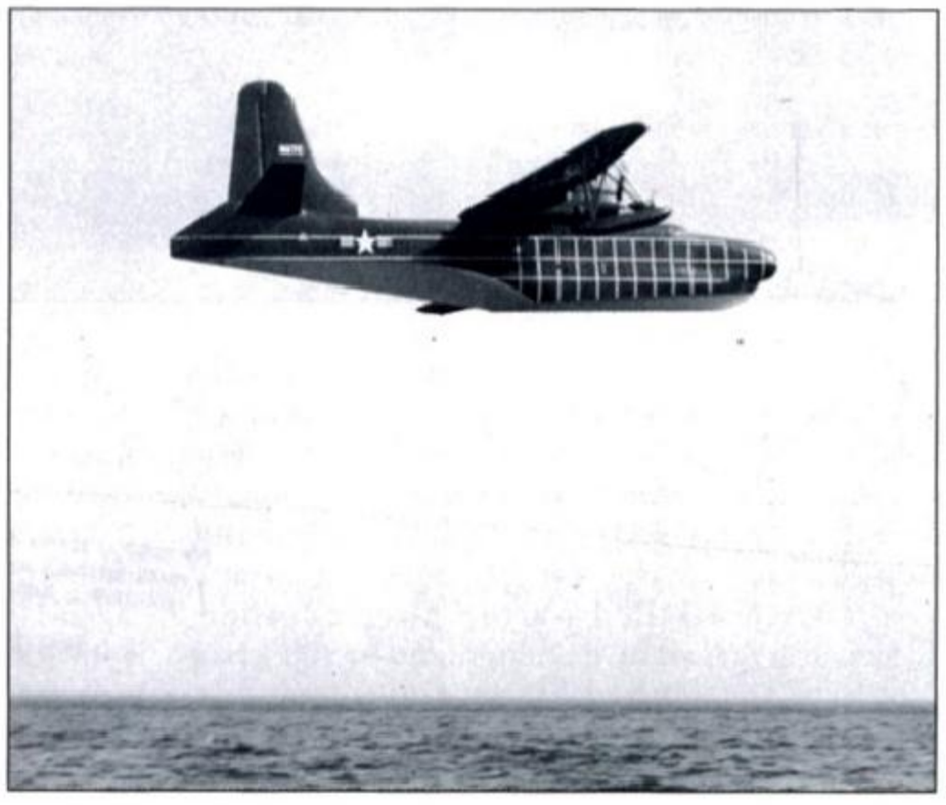
M-270 was the US Navy's official but non-standard designation for the Martin Model 270. This aircraft was the XP5M-1 Marlin prototype following its rebuild as a one-of-a-kind testbed for flying-boat research. Its purpose was to test a new, slimmer hull shape with a 15-to-1 hull-to-beam ratio, a concept that was developed over years of research and wind tunnel work, and was initially flight-tested on a Grumman J4F-2 named the *Petulant Porpoise*. In March 1951, Martin brought the XP5M-1 back to the factory and began reconstructing its hull. The company rebuilt the fuselage with its new-style hull, increasing length by 12 ft (3.65 m) to 91 ft 10 in (27.74 m). The M-270 retained its original wing design – that is, the PBM Mariner wing found on the XP5M-1 Marlin prototype – but was able to fly at weights up to 71,000 lb (32200 kg), or 11,000 lb (4990 kg) more than the XP5M-1.

The M-270 flew as a research aircraft for several years and helped to develop a body of knowledge that was used in design work on the P5M-2, P6M, and P7M designs. The M-270 eventually was scrapped.

BuNo. 98616


PBM Mariner floats and wings with leading-edge slats
Offset astrodome
Mariner 'crown section'
New tailcone
New single-step long-afterbody hull, 12 ft (3.66 m) longer than XP5M-1

Right and below: The M-270 is seen on and above Chesapeake Bay in mid-1952. The white grid pattern was painted to match the relative position of lines on the towing tank model (the flying-boat equivalent of a wind tunnel). The M-270 was originally a Mariner before conversion to the prototype Marlin. Throughout its career, the aircraft retained PBM wings and floats.



Other unbuilt variants

The files of the Martin Aviation Museum in Baltimore contain fragmentary information on many propeller-driven flying-boat concepts that were discussed, and sometimes designed, but not built. In many cases, almost no details have survived of aircraft concepts, some of which were little more than ideas. Before and during World War II, Martin looked at several versions of an enormous flying-boat before and after developing the PB2M/JRM Mars. After the war, Martin clearly hoped to cap the PBM Mariner's career by developing a four-engined ocean-going flying-boat in the same class as the Consolidated XP5Y-1. Still later, the manufacturer hoped to extend development of the P5M Marlin much farther than was actually done.

The Model 193 was a concept for a six-engined flying-boat which Martin hoped to build for military purposes during the war (Glenn L. Martin reportedly spoke of manufacturing 500) and as an airliner after the war.

The Model 225 was a long-range, four-engined flying-boat with Pratt & Whitney R-2800 engines proposed by the US Navy on 1 March 1945 as a Mariner replacement, and one of several drawing-board competitors to the XP5Y-1. The Model 230 was a separate 1945 proposal for a four-engined, long-range replacement for the Mariner.

The Model 290, referred to in some documents as the P5M-3 (the first of two uses of this designation), was an 'armed reconnaissance' version of the Marlin proposed in 1953. The Model 297, also called the P5M-Y, was an ASW patrol development of the Marlin. The Model 298 or P5M-X was a revamped ASW patrol aircraft, also a derivative of the Marlin.

An Industry of Prototypes

Sukhoi T-4

Russia's Mach 3 bomber

It is well known that the Soviet leader Nikita S. Khruschchev, who assumed office in 1953, had a soft spot for missiles. His biased defence policy set back Soviet military aviation immensely, and many promising designs such as the Tu-91 maritime attack aircraft were killed by the Soviet leader. However, the rapid development in the early 1960s of the United States' quick-reaction forces, especially carrierborne aviation, forced Khruschchev to change his point of view, and he agreed to the development of a new-generation strategic bomber/reconnaissance aircraft. It was to carry two to four air-to-surface missiles and be capable of destroying targets at a range of 800-1500 km (496-932 miles).

The basic requirements for the new bomber were outlined by the State Research Institute of Aviation Systems (GosNII AS) in Moscow after a careful analysis of the tasks the aircraft was to fulfil. Special importance was attached to attacking non-strategic enemy strike forces (primarily large surface ships such as aircraft-carriers, missile cruisers, ocean freighters, etc.), as well as land-based strategic targets (ICBM silos, command posts etc.). Strategic reconnaissance was regarded as a secondary role.

The aircraft was to have a Mach 3.0 top speed and a Mach 2.8 cruising speed, and be capable of operating from dirt strips as well as from paved ones. The structure was to be of heat-resistant steel and titanium.

Sukhoi's rivals

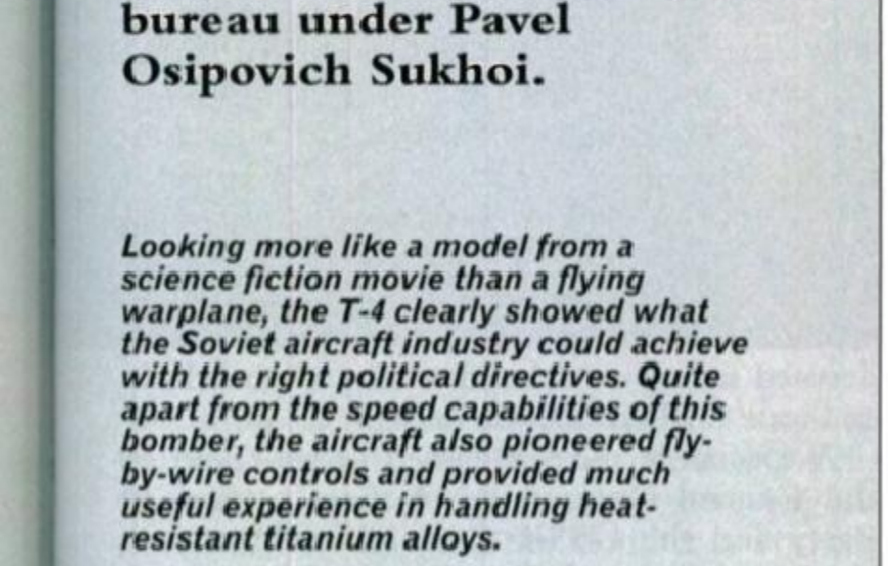
Several design bureaux (OKBs) were involved with the new weapons system. Andrei N. Tupolev's group was working on two preliminary designs – the Tu-125 and the Tu-135, the latter of which was similar in appearance to the North American XB-70 Valkyrie. The designation Tu-135 is sometimes erroneously applied to the Tu-134 *Balkany*, an airborne command post version of the Tu-134A airliner (to be precise, Tu-134AK, the VIP version). Aleksandr S. Yakovlev's OKB developed the Yak-33 project, and the Sukhoi OKB came up with the project 100. The designation was derived from the Sukhoi bomber's projected gross weight of 100 tonnes (220,470 lb). As such, the aircraft was often referred to as the *sotka* ('the hundred').

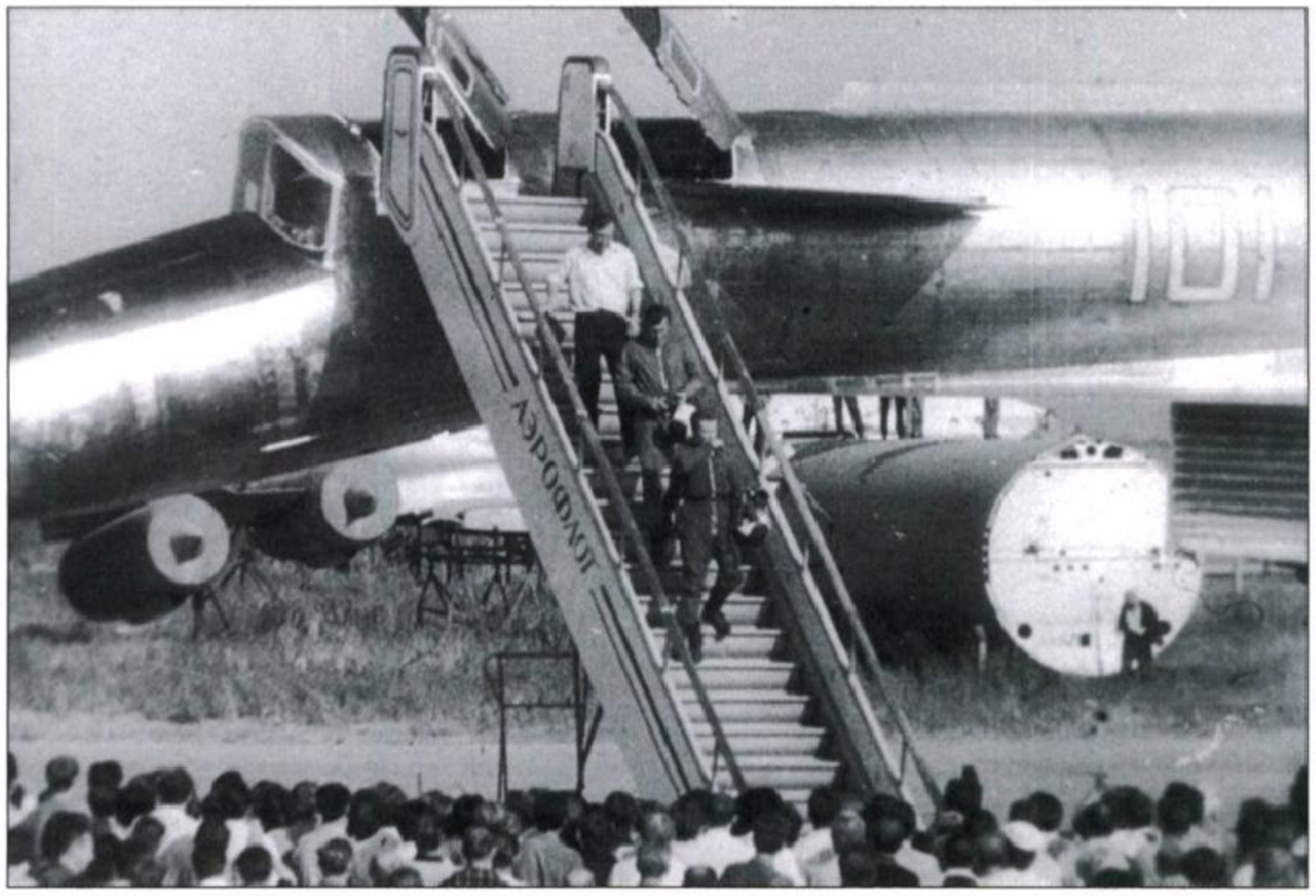
Two turbojets were initially considered to power the aircraft. One was the R15BF-300 designed by Sergei K. Tumanskii (an uprated version of the engine powering the MiG-25 'Foxbat'), rated at 98.07 kN (22,045 lb st) dry and 129.74-142.2 kN (29,166-31,966 lb st) in full afterburner. The other was the RD17-15 developed by Prokofiy Zoobets. Aleksandr Bereznyak's group was tasked with developing the anti-shipping missile for the bomber.

Tupolev was by then established as the leading Soviet bomber designer. Having to cope already with the rival Myasischchev OKB, he was not at all pleased to see more competition in the shape of Sukhoi. He knew Pavel Sukhoi well, since Sukhoi had been Tupolev's aide for many years. Annoyed by the young upstart challenging authority, Tupolev even remarked

In the Cold War years the Soviet Union was very active in developing new weapons systems, employing enormous funds and resources to keep the West at bay. One of the unique pieces of hardware created during this period was the T-4 strategic bomber, also known as *izdeliye* (product) 100, created by the design bureau under Pavel Osipovich Sukhoi.

Looking more like a model from a science fiction movie than a flying warplane, the T-4 clearly showed what the Soviet aircraft industry could achieve with the right political directives. Quite apart from the speed capabilities of this bomber, the aircraft also pioneered fly-by-wire controls and provided much useful experience in handling heat-resistant titanium alloys.





Sukhoi chief test pilot Vladimir Ilyushin leads Nikolay Alfyorov down the steps after the T-4's first flight. In the background is a fuselage section used for static pressure testing.

at a session of the State Committee for Aircraft (GKAT), "Sukhoi won't cope with such an aircraft. I know it because he was my student." Sukhoi was quick to retort: "I will cope – because, as you've rightly pointed out, I was your student!"

All three bureaux submitted their projects to GKAT for review. The Yakovlev project was rejected immediately because it did not meet Air Force requirements. The duel between the Tupolev and Sukhoi contenders continued for a long time, centring on the choice of structural materials (aluminium versus titanium and steel). Sukhoi's project 100 eventually won, receiving the go-ahead for advanced design studies. Its main design thrust was to select the optimum aerodynamic layout to permit prolonged Mach 3 flight at high altitude.

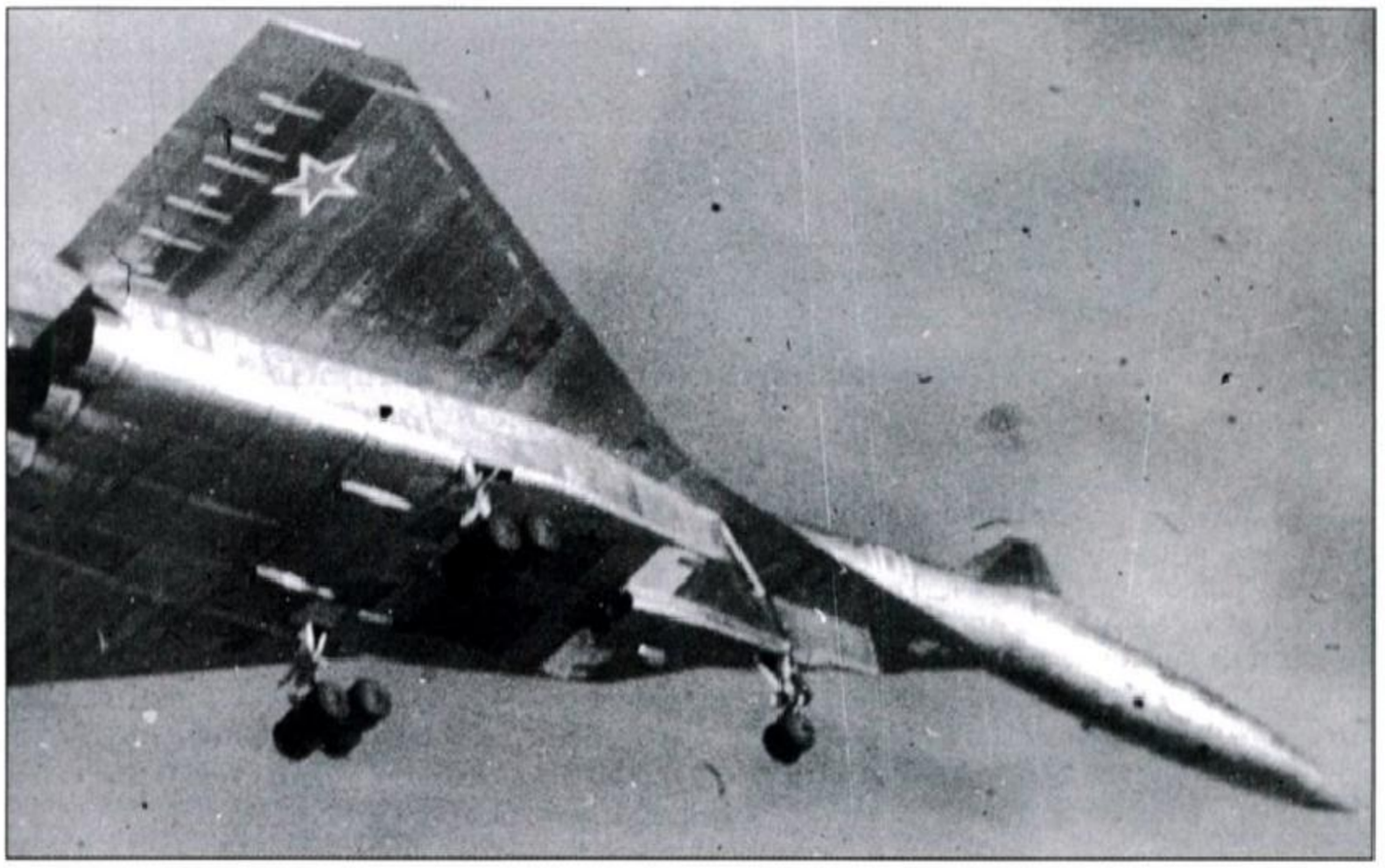
GKAT decision notwithstanding, Sukhoi was not out of the woods yet. To become final and binding, the decision had to be approved by government decree, and there was little hope of such a decree being signed. The project was closely scrutinised by numerous research institutes of GKAT and the Ministry of Defence, and eventually approved by all of them as technically sound. The Sukhoi engineers made huge efforts to obtain the all-important signatures of various government officials, and finally the decree was signed.

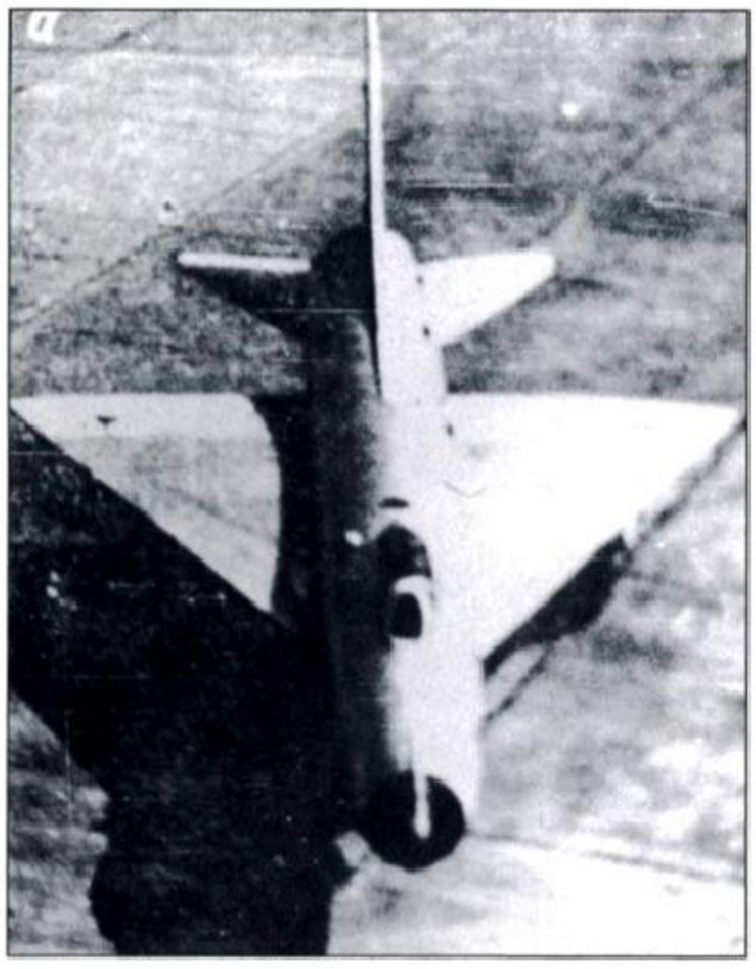
Designation logic

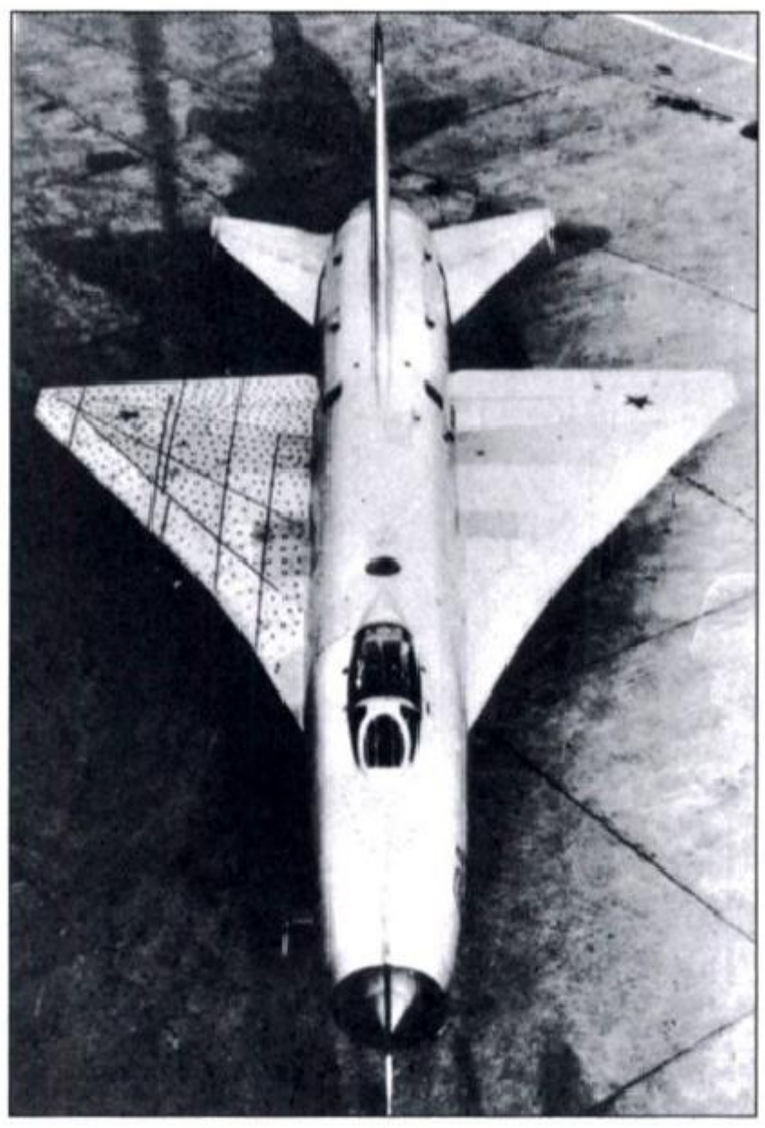
The manufacturer's designation given by the Sukhoi OKB to the project 100 was T-4. Originally the manufacturer's designations of Sukhoi aircraft were fairly logical and based on the wing planform. 'T' denoted *treoogol'noye* (*krylo*) = delta wing (e.g., T-58 = Su-15 'Flagon') and 'S' stood for *strelovidnoye* (*krylo*) = swept wing (e.g., S-1 = Su-7 Mk II 'Fitter-A'). Later, however, things became more complicated. For example, the experimental T-6-1 indeed had a delta wing, but proved unsatisfactory and evolved into the T-6-21 (the Su-24 'Fencer' prototype) with variable-geometry (swept) wings. Equally illogical are the swept-winged T-10 (Su-27 'Flanker'), or the T-8 (Su-25 'Frogfoot') and S-42 (Su-26 aerobatic aircraft), both of which have straight wings. The same goes for some of Sukhoi's current projects, such as the S-80 and S-84.

Pavel O. Sukhoi took the T-4 project very seriously, which many of his colleagues certainly did not. Yevgeni Ivanov, Sukhoi's first deputy, did not believe in the bomber project and was dead against it all along. The heads of some sections of the Sukhoi OKB also looked upon this departure from the bureau's traditional

The basic configuration of the T-4 naturally drew comparison with the XB-70 Valkyrie, but the Sukhoi bomber was smaller and could have been more versatile. This views highlights the trailing-edge elevons.

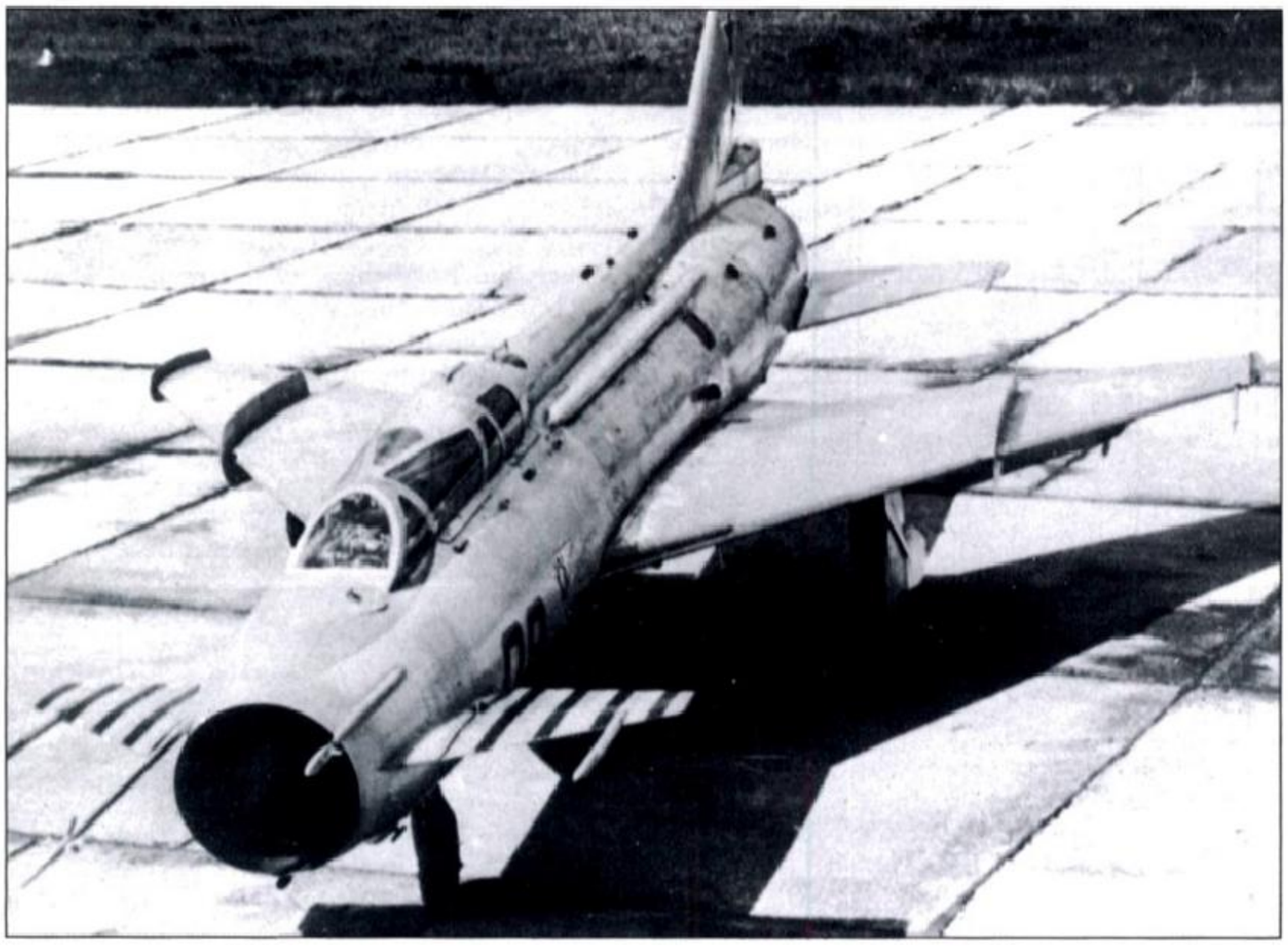






Above and right: This converted Su-9 'Fishpot' tested several wing planforms for the T-4 during 1966. Shown above is a straight 60° delta, while at right is a more sophisticated shape with cropped tips and an ogival inboard section. Note the wool tufts and markings applied on the starboard wing. The Su-9 was known as the 100L for these tests. It also flew with the 70°/60° double-delta eventually employed on the full-sized bomber.

Below: Another T-4 testbed was the 100LDU, an Su-7U equipped with foreplanes (with large mass balances) and a fly-by-wire control system. This first flew in 1968.



fighter theme with a jaundiced eye.

Pursuant to the government decree, the design bureau named after Semyon A. Lavochkin, and its experimental factory, were to assist Sukhoi with the T-4. The Lavochkin OKB had initially concentrated on fighter design, but had switched to missile development after its last aircraft programme (the La-250 interceptor) was abandoned in November 1957. However, Sukhoi's aides took so long to co-ordinate the joint work that eventually another 'customer' snatched Lavochkin's factory from them, giving it a different assignment. After that, the Moscow design bureau Burevestnik ('storm petrel'; pronounced boorevesnik) and the Tushino machine factory were assigned to the T-4 programme as branch offices of the Sukhoi OKB to assist in the design work.

The advanced design stage was largely completed in the second quarter of 1963. Reconnaissance, long-range interceptor and even airliner versions of the T-4 were envisaged in addition to the basic bomber version. The aircraft was to have a TOW of 100-110 tonnes (220,470-242,520 lb) and a range of 6000 km (3,730 miles) without drop tanks, cruising at 3000-3200 km/h (1,865-1,990 mph) at 20000-24000 m (65,620-78,740 ft).

In April 1963 the advanced design project was submitted to the Soviet Air Force (VVS) and GKAT for review. GKAT thoroughly went over the project and the Air Force's general operational requirements for the strike/reconnaissance aircraft, the sessions lasting from 21 May through 3 June 1963. Eventually, the commission ruled that the T-4 project submitted by the Sukhoi OKB met the VVS requirements as to purpose, projected performance data, armament and avionics, and that it was far superior to all contemporary aircraft in its class. The project documents of the T-4 powered by four R15BF-300 or RD17-15 engines were deemed sufficient to build a full-scale mock-up and issue final production drawings.

A special decree was passed in late 1963 by the Central Committee of the Communist Party and the USSR Council of Ministers, clearing the aircraft for full-scale development and setting a tentative first flight date of 1968. A broad spectrum of research organisations was to assist the Sukhoi OKB in the T-4 programme.

Final configuration

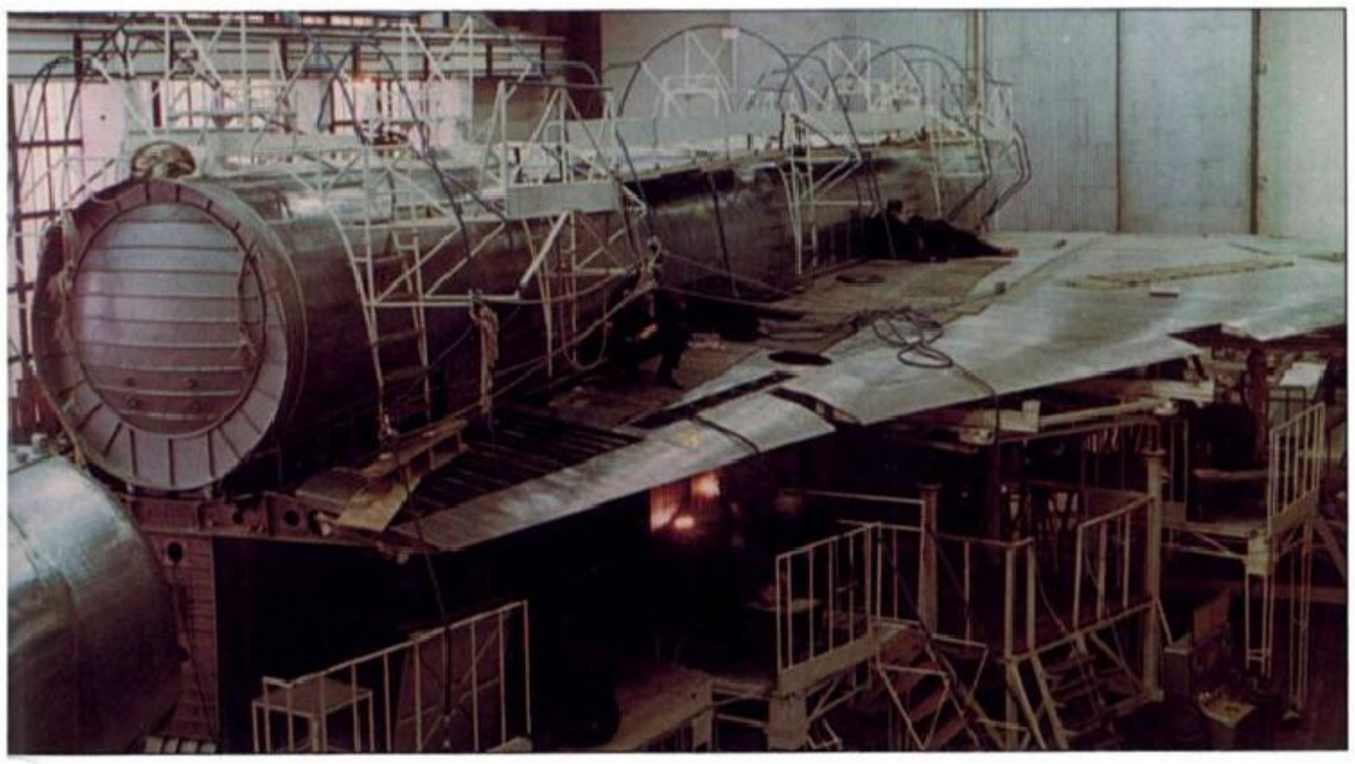
The configuration of the T-4 was finalised in 1964. It had a thin delta wing and movable canard foreplanes. The slender fuselage incorporated a low-drag cockpit canopy and housed all fuel and principal equipment. The engines were paired in nacelles under the wings, leaving the fuselage centreline and inner wings free for air-to-surface missiles carried on three hardpoints.

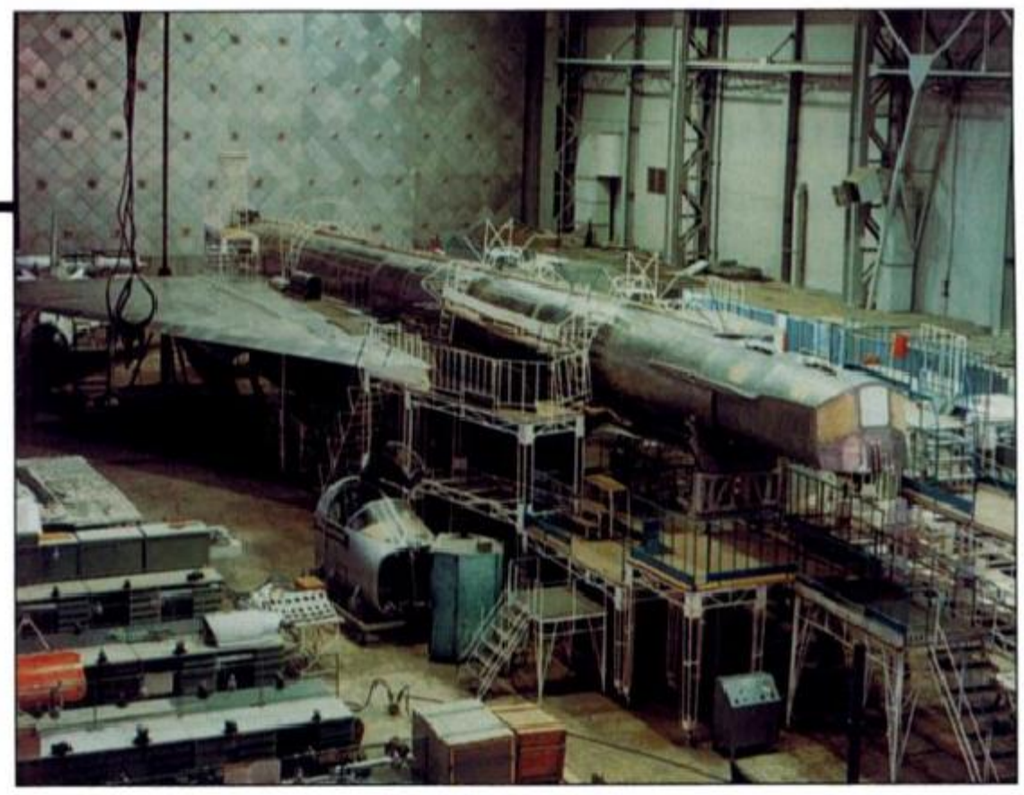
The Tushino machine factory was tasked with building the prototypes and static test airframes. The plant's directors immediately rebelled against this and fought a bitter but unsuccessful battle to get the order placed somewhere else.

A massive wind tunnel effort was undertaken by the Central Aero- and Hydrodynamics Institute (TsAGI) in 1963-1965. Numerous configurations were tested with varying wing sweep, aspect ratio and planform, different fuselage lengths, with or without protruding canopy and spine. Various shapes and areas of fin and canard foreplanes were compared, and the location of the canards was carefully chosen. The placement of the engines was also changed several times.

Eventually, two possible layouts remained – the initial one (with engines in twin nacelles) and another with all four engines grouped under the fuselage. The latter arrangement decreased drag and surface area and gave better integration between the engine package and the wings, increasing the aerodynamic efficiency of the latter. This 'all together now' layout was selected as the definitive one, and further work at the design bureau and TsAGI was directed at refining it.

In 1965 the 'subcontractor' design bureaux received assignments to design the aircraft's various systems. By then, both the Tumanskii R15BF-300 and the Zoobets RD17-15 had been rejected. When the full-scale mock-up was completed and demonstrated to the VVS in December 1966, right on schedule, four 156.91-kN (35,273-lb st) RD36-41 afterburn-





Three photographs show the prototype T-4 in various stages of assembly in the Tushino factory. The view left shows the wing-fuselage joint which allowed the fuselage to be constructed as a simple tube, while that above provides detail of the canard joints and drooping nose attachment. The T-4 was a major structural challenge due to the new materials being employed.

ing turbojets were specified as the T-4's powerplant. Developed by Pyotr A. Kolesov of the Rybinsk engine design bureau, these engines (RKBM) would give the bomber a cruising speed of 3200 km/h (1,990 mph) at 20000 m (65,620 ft).

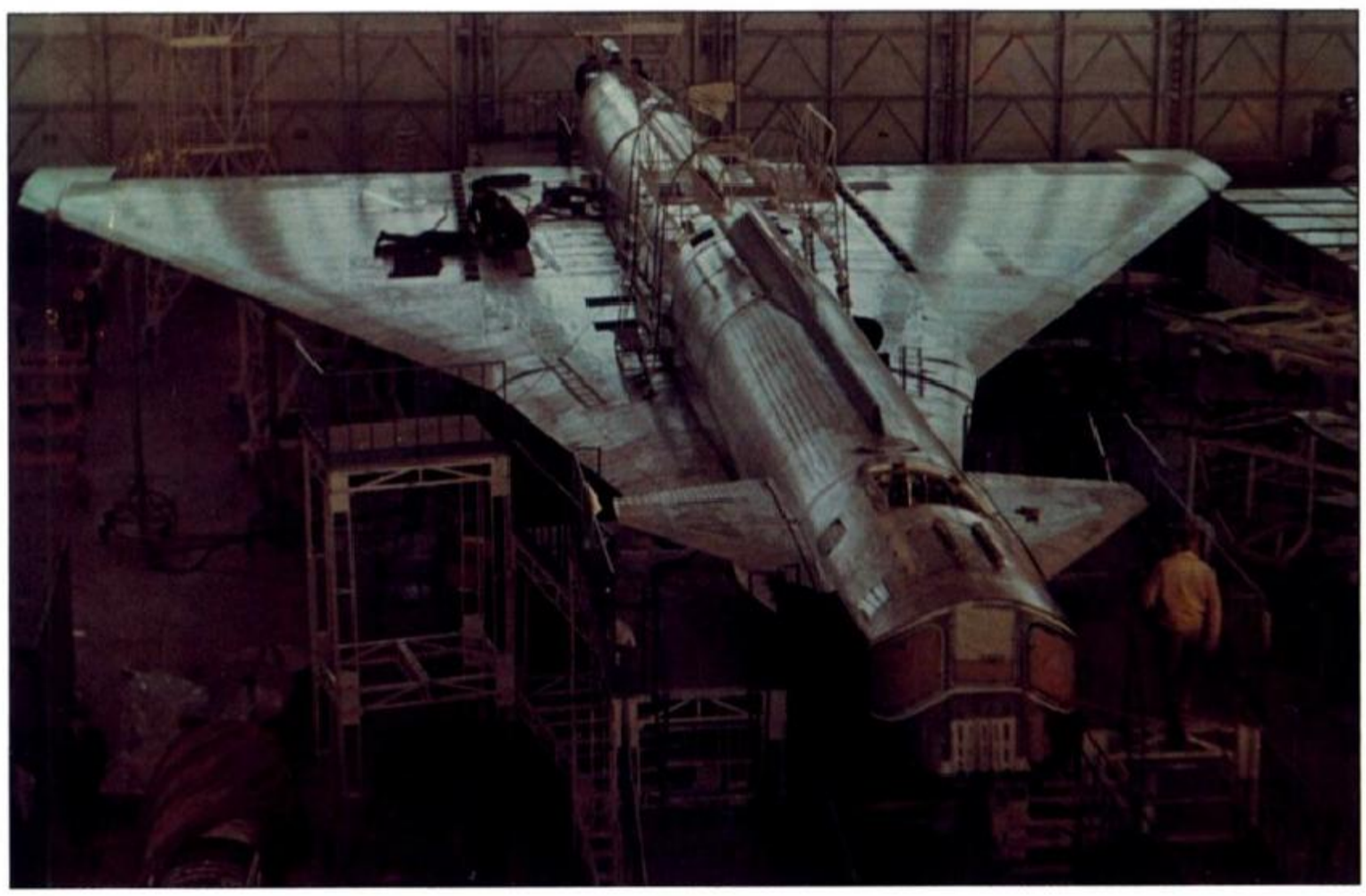
Between 17 January and 2 February 1967, the so-called 'mock-up commission', which was to approve the aircraft at this development stage, reviewed two basic configurations of the T-4. The strike and reconnaissance versions were in effect different equipment packages fitted to the same basic aircraft; the reconnaissance version was to carry part of the equipment internally and the rest in detachable pods.

Wing particulars

The full-scale mock-up had an overall length of 43.7 m (143 ft 4.5 in) and a wing span of 22.0 m (72 ft 2 in). The double-delta wing had a thin symmetrical section with a thickness-to-chord ratio of 2.7 per cent and a sharp leading edge; wing area was 291 m^2 (3,132 sq ft). Leading-edge sweep was 70° on the inboard panels and 60° on the outboard panels. This and other wing planforms had been evaluated in 1966 on a converted Su-9 'Fishpot' interceptor known as the '100L' (i.e., testbed for the project 100; L stood for [*letayuschchaya*] *laboratoriya*, or testbed).

The use of canard foreplanes for fore-and-aft balancing minimised the loss of wing lift due to trim changes (the aircraft was designed to be dynamically unstable – stability margins were 2 per cent at subsonic speeds and 3-5 per cent at supersonic speeds) and decreased control surface hinge moments. The low stability margins were achieved by altering the centre of gravity position by pumping fuel between tanks. The single all-moving fin made for a minimum directional stability margin, and the required stability and controllability characteristics were attained by the use of a fly-by-wire control system – incidentally, the world's first. Pitch and bank control was provided by elevons.

The four engines were installed in a single large nacelle, with the air intake split into two halves for the port and starboard engines. Georgiy Svischchev, the director of TsAGI at the time, remarked mockingly that "the common bed won't work" when he saw the paired intakes. However, wind tunnel tests at TsAGI proved that he was wrong – the engines performed flawlessly.



The T-4's normal TOW was to be 104.6 tonnes (230,614 lb) and the maximum TOW in overload condition 122.9 tonnes (270,960 lb). Range without drop tanks at a cruising speed of 3000 km/h (1,865 mph) was 6200 km (3,850 miles). The mock-up commission also examined the proposed avionics fit and armament, finally stating that in general the T-4 met the requirements but remarking that the work at the OKB and Tushino plant was running somewhat behind schedule. Measures were developed to quicken the work and make up for time lost.

Propulsion developments

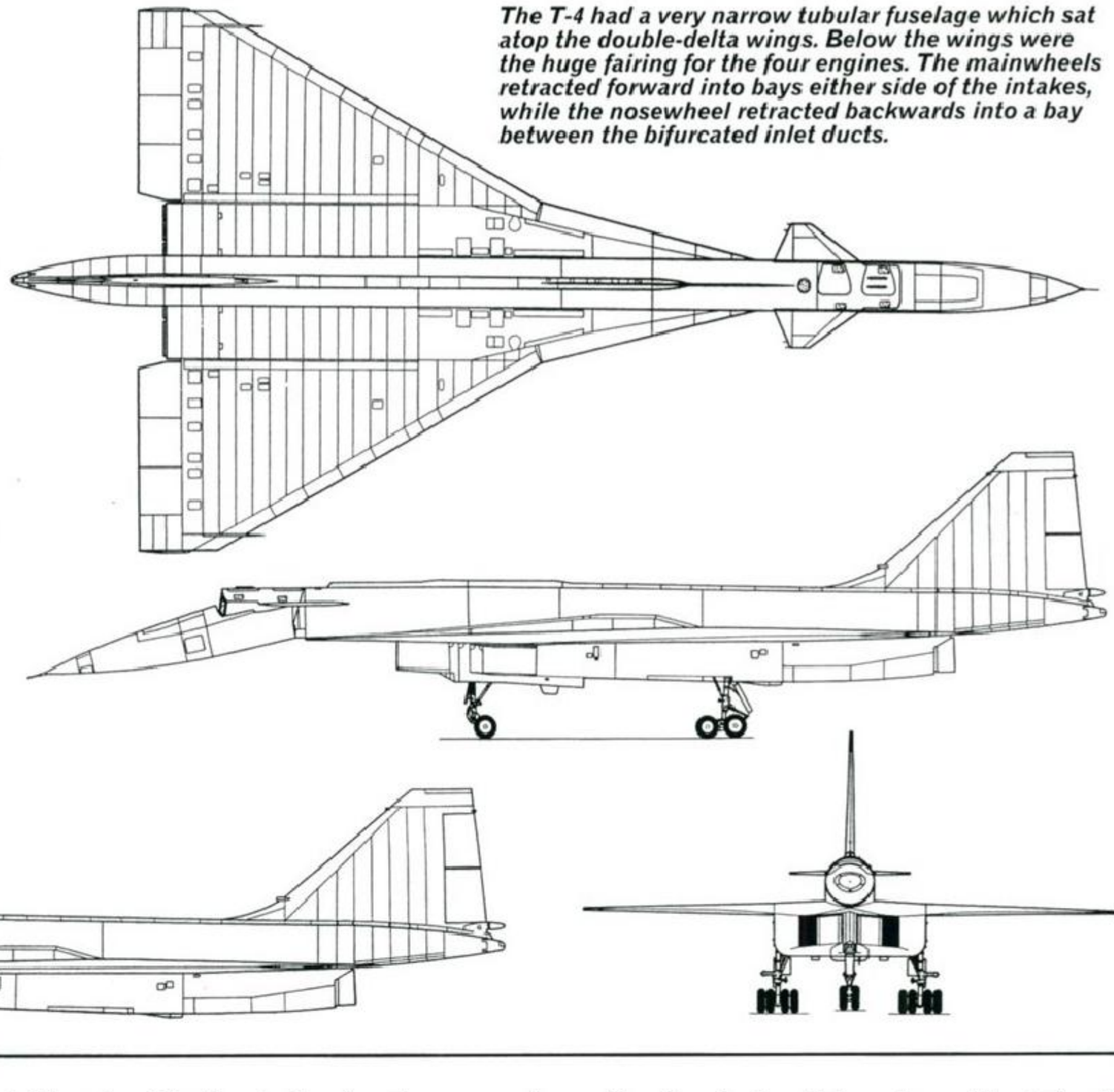
Because the aircraft would be subjected to immense heating when flying at three times the speed of sound, a new fuel brand with a high flash point, RG-1 (naphthyl), had to be developed for the T-4. This was the Soviet equivalent of JP-7. The engines had a full authority electronic control system (one might be tempted to use the term FADEC – full authority digital engine control – but the system was not digital). Pressurising the fuel system with neutral gas to minimise explosion hazard in the event of damage is nothing new, but for the first time on a Soviet aircraft the fuel tanks were pressurised using liquid nitrogen. A fuel jettisoning system was provided, and special movable heat-resistant joints were designed for the fuel lines. To refine and debug the powerplant, a model with Dobrynin VD-19 engines and another with Type 79R engines were built and tested at the Central Institute of Aero Engines (TsIAM).

As mentioned earlier, the *sotka* was a dynamically unstable aircraft with FBW controls, but these controls had not been present from inception. Initially, a conventional mechanical control system was to be fitted, with special dampers on the control cables to take up the slack caused by airframe deformations during heating-cooling cycles. However, this proved to be too complicated for use as the main control system. After much arguing with his aides, Sukhoi suggested fitting a quadruply-redundant FBW control system; the first prototype would be fitted with a mechanical control system as a back-up.

Another interesting feature of the T-4 was its auto-throttle. Its use was necessitated by the extremely low aspect ratio of the wings (1.7) and the high drag generated by the wings at the high angles of attack characteristic for take-off and landing. Thus, engine thrust had to be increased rather than decreased during

Specification

Accommodation: pilot and navigator
Overall length: 44.50 m (146 ft 0 in)
Wingspan: 22.00 m (72 ft 2 in)
Height: 11.19 m (36 ft 8.5 in)
Wheel base: 10.37 m (34 ft 0 in)
Wheel track: 5.88 m (19 ft 3.5 in)
Wing area: 295.7 m² (3,180 sq ft)
Wing aspect ratio: 1.7
Leading-edge sweep: outer wings 60° 7′; inner wings (LERX) 75° 44′
Canard foreplane area: 10.9 m² (117 sq ft)
Fin area: 35.0 m² (376.34 sq ft)
Nose visor droop angle: 12° 12′
Fuselage diameter: 2.0 m (6 ft 6.75 in)
MTOW: 136000 kg (299,823 lb)
Normal TOW: 128000 kg (282,186 lb)
Empty weight: 54800 kg (120,811 lb)
Internal fuel load: 69000 kg (152,116 lb)
Maximum payload: 19000 kg (41,887 lb)
Maximum speed: at sea level 1150 km/h (714 mph); at cruise altitude 3200 km/h (1,987 mph)
Cruising speed: subsonic at sea level 900 km/h (559 mph); subsonic at cruise altitude 950 km/h (590 km/h)
Service ceiling: 20000-24000 m (65,620-78,740 ft)
Range: without drop tank 6000 km (3,726 miles); with drop tanks 6500 km (4,037 miles)
Take-off run: 1500 m (4,921 ft)
Landing run: 1100 m (3,608 ft)
Powerplant: four Kolesov RD36-41 afterburning turbojets each rated at 156.91 kN (35,273 lb st) with afterburning
Thrust-to-weight ratio: 0.5 at normal TOW
Wing loading: 440 kg/m² (90.21 lb/sq ft) at normal TOW



The T-4 had a very narrow tubular fuselage which sat atop the double-delta wings. Below the wings were the huge fairing for the four engines. The mainwheels retracted forward into bays either side of the intakes, while the nosewheel retracted backwards into a bay between the bifurcated inlet ducts.

approach; the auto-throttle controlled that, even though the pilot throttled back as usual during landing.

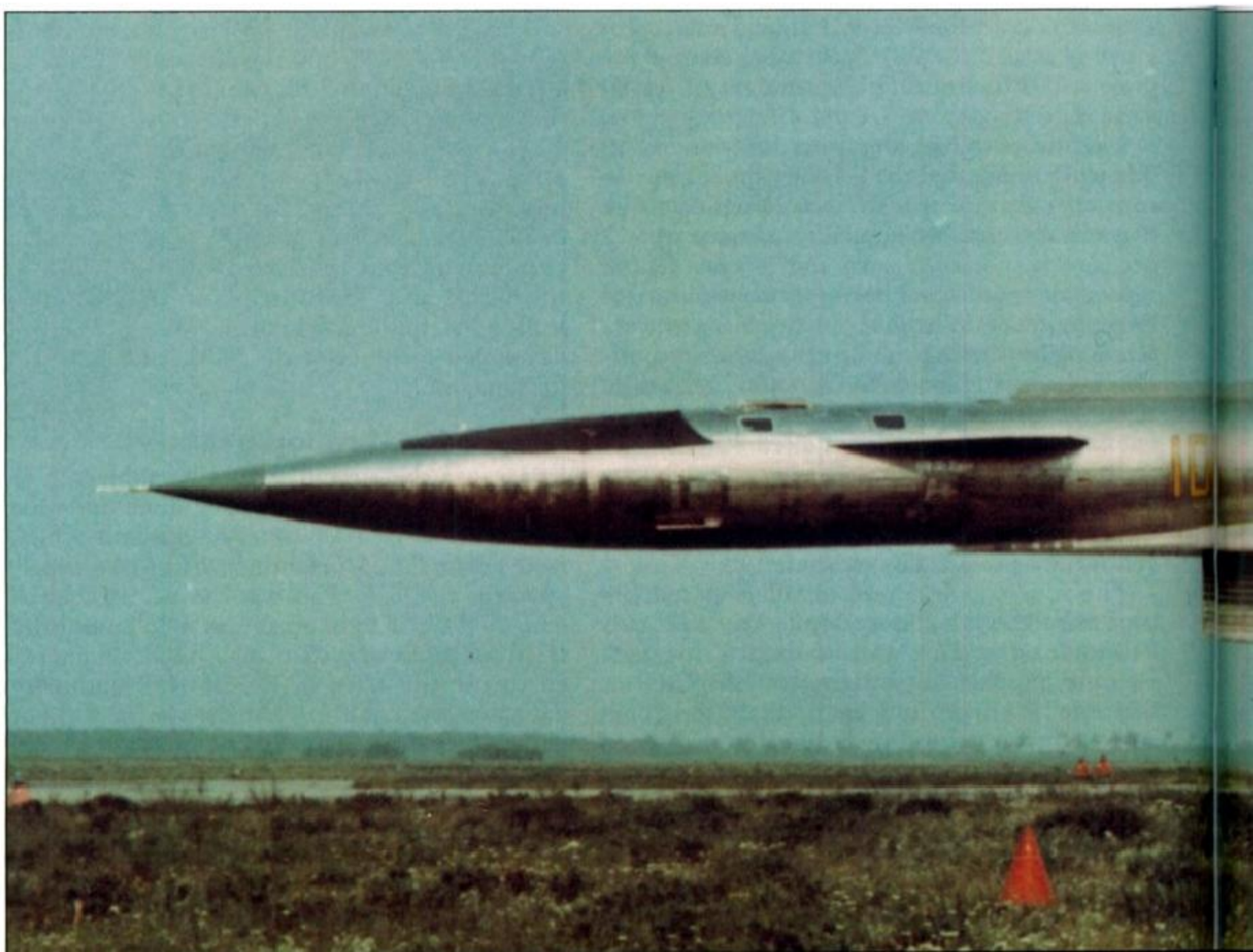
Special avionics, communications and ECM suites, radar and targeting equipment were created for the T-4. The main computer allowed many operations to be automated and the aircraft to be flown by a crew of two (pilot and weapons systems operator).

Anti-ship missile

The T-4 programme was marked by another 'first' in Soviet aeronautical engineering history: the Sukhoi OKB, which traditionally dealt with aircraft only, designed an anti-shipping missile. The Kh-45 was created specially for the *sotka* (in the definitive version, the aircraft was to carry two of these weapons) and had a range of 1500 km (930 miles). The missile was equipped with a unique combined guidance system: it had semi-active radar homing and was guided to the target by the T-4's powerful radar most of the way, but switched to active radar homing at the final stage of the trajectory. For reconnaissance tasks, the aircraft could carry SLAR, IR sensors and cameras.

From 1968, the RD36-41 turbojet was tested at subsonic speeds on one of the seven Tu-16LL 'Badger' engine testbeds operated by the Flight Research Institute (LII). Il-18 'Coot-A' and Tu-104B 'Camel' airliners, Tu-22 'Blinder' bombers and An-12 'Cub' transports were converted into avionics and weapons testbeds, verifying the T-4's radar, avionics and targeting system, testing the communications and navigational aerials in kinetic heating conditions, and trialling the Kh-45 missile. Another research vehicle to join the programme in 1968 was a converted Su-7U 'Moujik' trainer recognisable by its non-standard canard foreplanes, known as the 100LDU FBW testbed (i.e., *proyekt* 100, *laboratoriya* [*dlya ispytahniya sistemy*] *distantseeonnovo oopravleniya*). The designation is somewhat misleading; it should have been *laboratoriya dlya ispytahniya elektrodistantseeonnoy sistemy oopravleniya*, because '*sistemy distantseeonnovo oopravleniya*' means 'remote control system', and radio-controlled drones were certainly not involved!

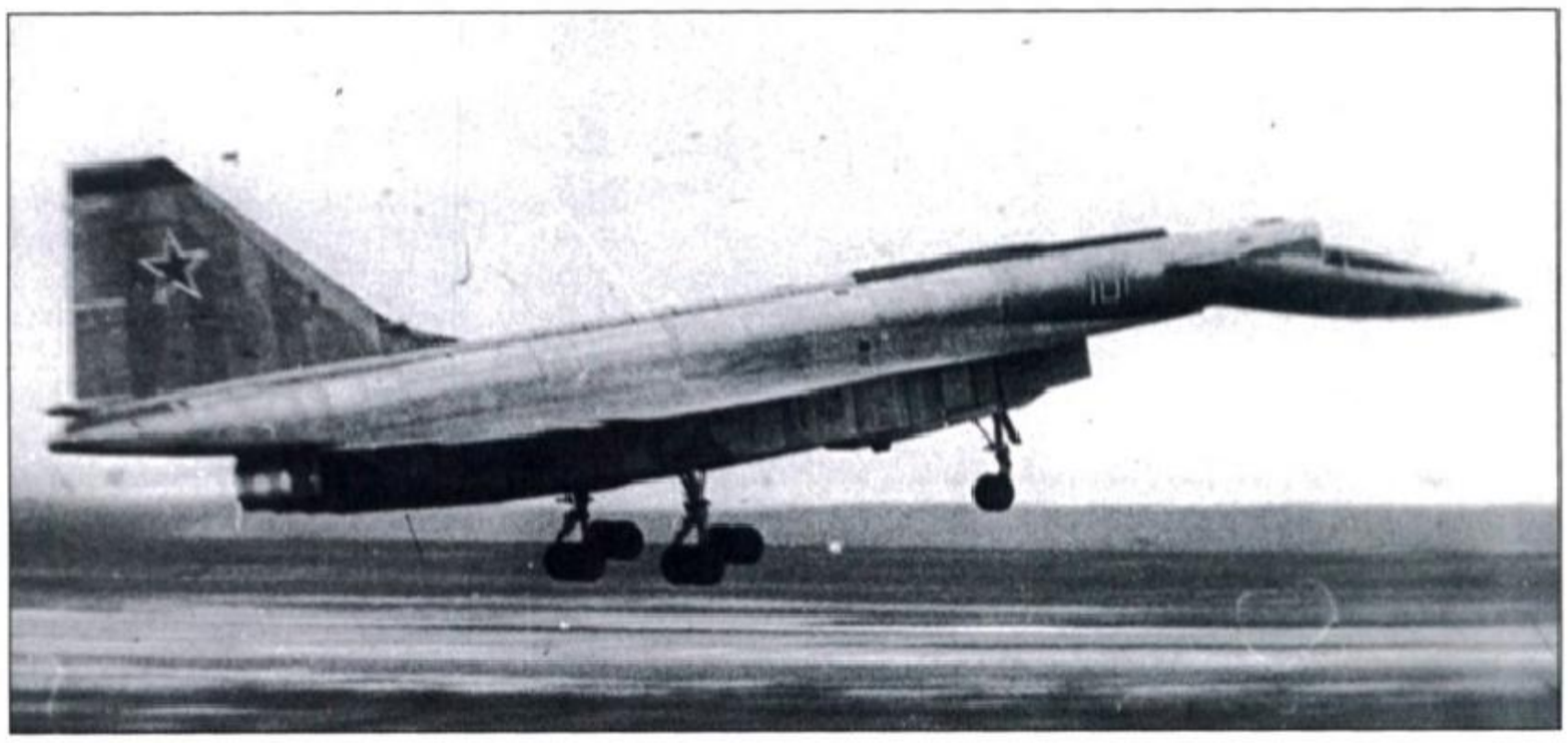
One of the biggest problems the designers



These views show Black 101 taking off in afterburner (right) and landing (above). For the latter, four cruciform brake chutes were housed in the tailcone, immediately below the bullet fairing for electronic warfare equipment. Landing was accomplished using the autothrottle, which actually increased thrust to offset the extra drag.

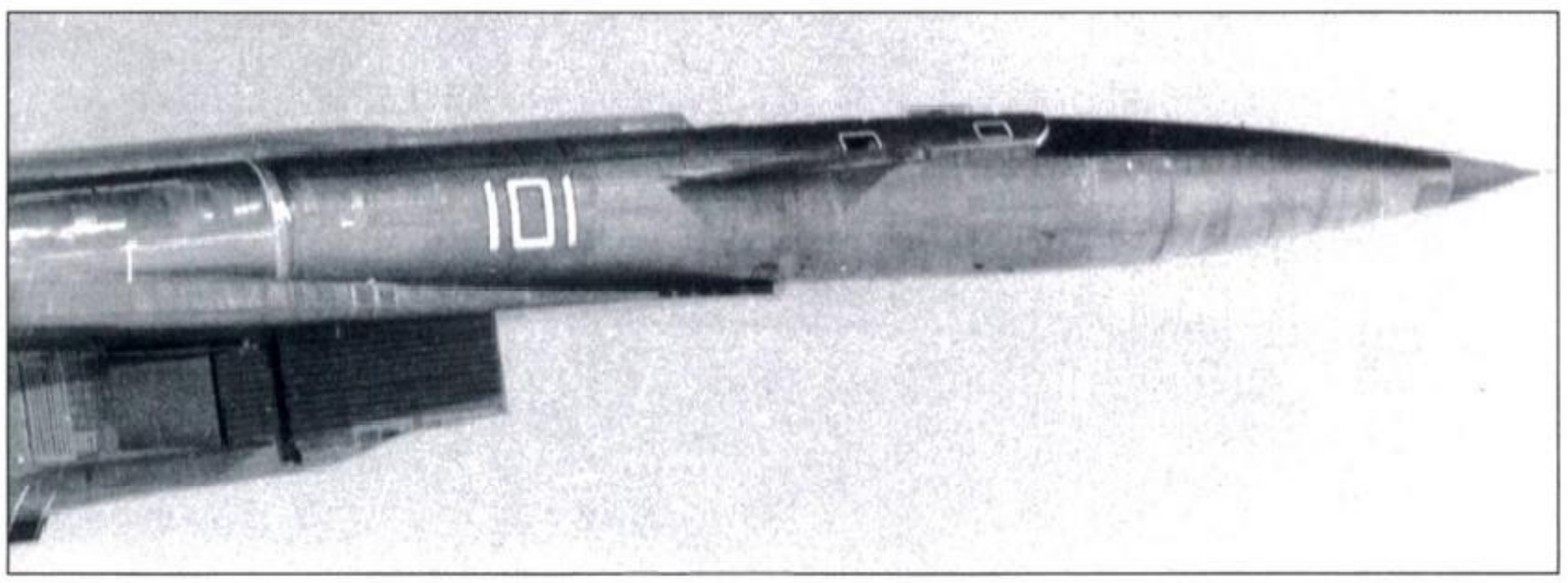
had to face was airframe heating at high Mach numbers. This led to the development of heat-resistant titanium alloys (VT-20, VT-22) and steels (VNS-2), as well as proper technologies of shaping, machining, welding and casting them. VT: *vysokoprochnyy teetahn* means high-strength titanium; VNS: *vysokoprochnaya nerzhaveyuschchaya stahl* means high-strength stainless steel.

Work on the T-4 proceeded quickly, but problems still arose. One such was whether to use a control column or a fighter-type stick. The issue was really a psychological one, not one of safety, in that on heavy bombers the control column swung forward before ejection to avoid injuring the pilot. Long-range bomber pilots who were to fly the T-4 were adamant, demanding that a control column be used since this fit better into bomber pilots' flying stereotypes. Yet many bomber pilots converted to bombers after flying fighters in flying schools, i.e., they had to make the transition from stick

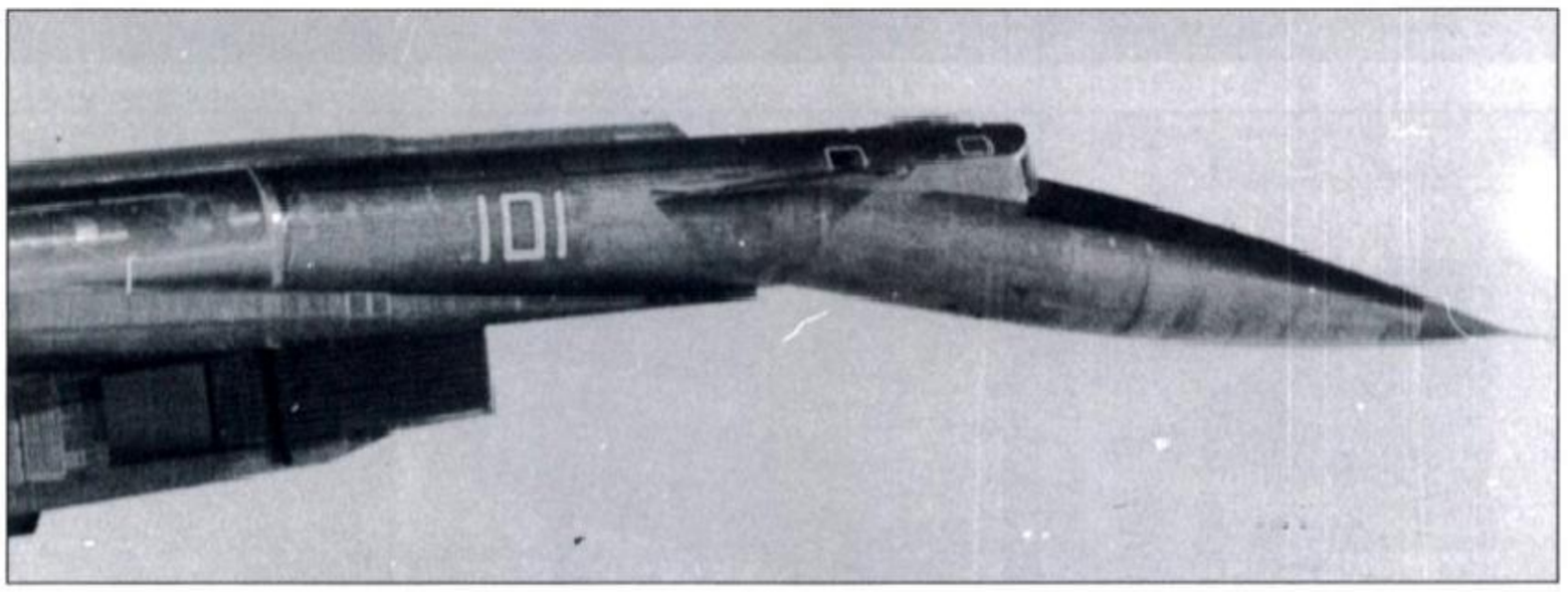


Below: Quite apart from its primary bomber role, the T-4 was intended to perform strategic reconnaissance and anti-shipping missions. For the latter Sukhoi designed the dedicated Kh-45 missile, which employed semi-active guidance with active radar homing in the terminal phase.

An Industry of Prototypes



Like Concorde and the Tu-144 supersonic airliners, the T-4 adopted a drooping nose as the only practical means of meeting the aerodynamic requirements of high speed and the visibility needs of the crew on landing. With the nose up, the crew operated almost entirely on instruments, although small windows were provided for some measure of outside view.



to wheel. Fitting a stick to the T-4 eliminated this transition. Another argument in favour of the stick was that a control wheel would obscure much of the T-4's small instrument panel; besides, a stick was easier to handle in a high-altitude pressure suit.

Because of the kinetic heating of the airframe to 300°C (570°F), the cockpit canopy was dispensed with and the cockpit was completely buried in the fuselage. The crew entered via a circular dorsal hatch, which on the first prototype was fitted with a periscope for the pilot. For take-off and landing, the nose forward of the cockpit was drooped, revealing the glazing and giving the pilot an excellent field of view.

In 1966 the Sukhoi OKB's projects division started issuing documents on the first prototype, designated 'aircraft 101' and appropriately coded '101 Black'. The drawings of the first prototype and the static test airframe were not completed until 1968 and had to be issued

The considerable weight of the T-4 rested on eight-wheel main bogies. In flight the bogies were angled back (like that of a Boeing 747) so that the rear wheels touched down first.

piecemeal, yet the Tushino machine factory received drawings of the wing centre-section and fuselage integral fuel tanks in late 1966.

In 1969 the first sections of the airframe were completed and trucked to the Sukhoi OKB's experimental plant for final assembly, which took all of 1970 and continued well into 1971. Unbelievably, the prototype's RD36-41 engines were delivered right on schedule, which was a rare occurrence for the Soviet aircraft industry. Following completion of ground system checks, aircraft 101 was delivered to LII in Zhukhovskii to commence flight tests.

The second airframe, designated 'aircraft 100S' (for *stateecheskiye ispytaniya* – static testing) was completed by the Tushino plant in 1972 and turned over to TsAGI for static and thermal load tests in Zhukhovskii. The fuselage and nose visor, cockpit and equipment bays, canard foreplanes, elevons, landing gear, engine nacelles etc. were subjected to stringent tests. The forward fuselage with cockpit and equipment bays was heated to 270°C (520°F) in a heating chamber. Static tests were 55 per cent completed by the time Stage 1 of flight testing began, and structural strength was found to be adequate.

While working on the T-4, the Tushino machine factory was learning to handle heat-resistant steel and titanium, materials with which the Soviet aircraft industry had no experience at the time. A new shop was set up for this, and the plant gradually started reorganising and upgrading. A new testing technique was introduced for the T-4's structural components. To this end, a measurement complex was developed which captured 1,500 different parameters by telemetry and recorded them on magnetic tape.

T-4 component production was completely automated, as were 95 per cent of the welding jobs. Waste of material was kept virtually to nil. As a result, the aircraft was no more complicated to build than if it had been made of the usual aluminium alloys, which are far easier to machine.

The first prototype arrived at Zhukhovskii on 30 December 1971. For the duration of the flight test period the Myasischchev OKB had let the Sukhoi team use the greater part of its hangar and service rooms. A special analytical group was set up by Sukhoi and the people 'camped out' at the airfield for months, living in trailers. For four long months, the T-4's equipment was tested and debugged and the engines were run. Taxi tests included 12 runs (four of them high-speed runs) and two aborted take-offs. The aircraft was serviced by a ground crew of no fewer than 70 people – both Sukhoi and LII personnel – carefully selected for skill and experience and specially trained.

T-4 takes to the air

When the aircraft was finally ready to fly, there was a setback. Exceptional heat caused forest fires around Zhukhovskii and a pall of smoke enveloped the airfield. Each day the T-4 would line up for take-off, and each time the take-off was cancelled because of the smoke. Pavel Sukhoi showed up from time to time to check on progress, but unfortunately he was not there on the day of the first flight. On 22 August 1972 the *sotka* finally took off on a 40-minute first flight, piloted by Sukhoi's chief test pilot Distinguished Test Pilot Vladimir Ilyushin, with Distinguished Test Navigator Nikolay Alfyorov (these titles are official grades reflecting their expertise).

The engines performed satisfactorily on the flight. Severe overheating of the aft fuselage fuel tank was experienced but the problem was solved by adding a steel heat shield designed by A. Potopalov of MKB Burevestnik, using a technique developed by Sukhoi engineer V. Gladyshev. Some problems with the hydraulics were also evident, despite the fact that a special test rig had been built for the aircraft's four hydraulic systems.

The landing gear stayed down for the first five flights, malfunctioned during the third and fifth flights, but operated normally from the sixth flight. In the ninth flight the T-4 cracked the sound barrier, attaining Mach 1.28. Having no forward vision when the nose visor was up, the pilot had to fly IFR almost continuously; this was not too difficult, since the T-4 handled well and was easy to fly.

The prototype made only 10 flights:

Number	Date	Duration
1	22/8/72	40 min
2	1/173	41 min
3	2/273	34 min
4	13/4/73	53 min
5	19/4/73	1 hr 24 min
6	24/5/73	50 min
7	15/6/73	1 hr 55 min
8	26/673	1 hr 16 min
9	8/873	1 hr 6 min
10	22/1/74	1 hr 1 min
total time	**10 hr 20 min**	

The flights revealed that the aircraft was easy to control on the ground and had no tendency

***In 1982 the T-4 prototype entered the VVS museum at Monino, creating something of a stir among Western observers. It was labelled as the 'Su-100', an alternative designation that gave rise to the nickname* sotka.**

to yaw or pitch up during the take-off run. Cockpit visibility with the nose visor lowered was excellent, greatly facilitating taxiing, taking-off and landing. The aircraft left the ground smoothly and gave no problems in level flight. The T-4 slipped through the sound barrier so smoothly that only the Mach meter gave any indication. Approach and landing presented no problems, either, as the auto-throttle minimised pilot workload and the aircraft had no tendency to drop the nose prematurely and was stable during the landing run. The FBW system was engaged throughout from the first flight and operated flawlessly, ensuring good controllability. The back-up mechanical controls were also tested but required excessive stick and pedal forces to fly the aircraft.

During Stage 1 of the test programme, the prototype reached Mach 1.28 and 12100 m (39,700 ft). Stage 1 indicated that the T-4's actual performance matched the project specifications and that no failures had occurred along the welded seams.

Construction programme

Meanwhile, construction of additional airframes had begun at the Tushino plant. Drawings and specifications of the second prototype (aircraft 102) began arriving in 1968, and manufacturing began the next year. The aircraft was completed in 1973, scheduled to enter flight test in the fourth quarter of the year. Major sections of the third prototype (aircraft 103) were built, final assembly being scheduled for 1973 and flight tests for the third quarter of 1974. Aircraft 104, 105 and 106 were also planned.

At Stage 2 of the test programme, aircraft 101 was to be used for systems verification, high-speed handling and performance tests.

Black 101 made only 10 flights before the programme was cancelled, and the completed second prototype never flew. Six prototypes were planned, construction having started on the third. If production had been authorised, at least 250 T-4s would have been built.

Aircraft 102 would be used to check out the navigation system, and aircraft 103 and 104 would carry out live missile launches (104 would also evaluate the bomb armament and be used to determine the range). Finally, aircraft 105 would be used to check avionics integration and aircraft 106 to verify the strike/reconnaissance system as a whole.

The Air Force request for the 1970-1975 five-year plan included 250 T-4 bombers to be built at the Kazan aircraft factory, which came as a shock to the then Minister of Aircraft Industry, Pyotr V. Dementyev. Meanwhile, Tupolev, sensing the threat to his position, kept urging everyone to "leave well enough alone" and go for improved versions of the Tu-22, arguing that modifying the 'Blinder' would be much easier than trying to build the T-4.

Concurrently, the VVS placed a large order for MiG-23 'Flogger' tactical fighters. Dementyev promised Defence Minister Marshal Andrey Grechko that the order could be filled if the T-4 programme was cancelled, and that tipped the scales. Soon a directive was issued, ordering the construction of the Tu-22M (M=modified). That designation was totally misleading, for the Tu-22M was an all-new bomber having nothing in common with the Tu-22 proper (OKB designation Tu-105A); hence the new NATO codename 'Backfire'. It is not known if Tupolev had deliberately concealed that fact. Tu-22M construction sounded the death knell of the T-4. The tooling prepared at Kazan for building the aircraft was gradually scrapped, as were the unfinished airframes at Tushino.

The first prototype, 101 Black, was donated to the VVS Museum in Monino near Moscow in 1982. Parts of aircraft 102 were used as teaching aids at the Moscow Aviation Institute for a while, but were scrapped eventually.

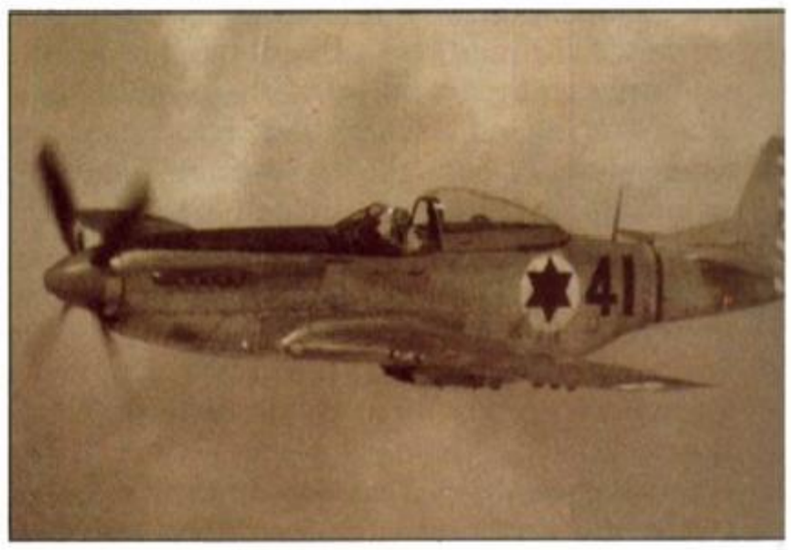
After the demise of project 100, the Sukhoi OKB continued working with strike aircraft at its own risk, developing the T-4M and T-4MS projects. Both used variable geometry (the T-4MS, moreover, used stealth technology). The aircraft never materialised, losing out to the Tupolev OKB's project 70 (the future Tu-160 'Blackjack') as the Soviet Union's answer to the Rockwell International B-1 in the arms race.

To quote Kurt Vonnegut, "so it goes." Tradition turned out to be just too strong. Still, the T-4 has undoubtedly earned itself a place among the masterpieces of world aircraft engineering.

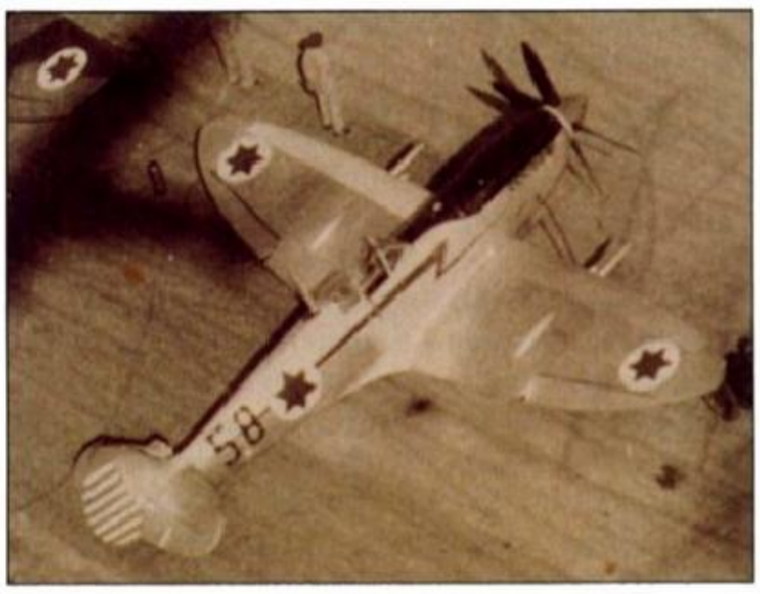
Yefim Gordon; original translation by Dmitri Komissarov

Israel 1950-1959

The 1950s were the formative years of the Israel Defence Force/Air Force (IDF/AF). At the beginning of the decade the IDF/AF was a fledgling air arm struggling to secure its place among the IDF structure amid a deep economic depression. As the decade progressed the IDF/AF was expanded, modernised and combat-tested. When the decade ended all the IDF/AF front-line units (except one) were flying jet fighters, and most of its aircrews were combat-proven. Those pilots and navigators became the leaders of the IDF/AF in the 1960s when it earned its worldwide fame.



This P-51D wears the red and white rudder markings of 101 Sqn and retains the fuselage identification band from the 1948 fighting. The P-51 became the IDF/AF's most important fighter in the early part of the 1950s.



At the start of the 1950s the Spitfire Mk 9 was the primary fighter of the IDF/AF. Serviceable aircraft were operated by 101 Sqn alongside a small but growing Mustang fleet.

By today's standards, a decade rarely brings significant changes in air warfare technology. In 1980 the best fighter pilots of the Israel Defence Force/Air Force flew the McDonnell Douglas F-15 Eagle; they still flew the same basic airframe in 1989, and will continue to do so beyond the turn of the century. Five decades ago things were very different. An IDF/AF fighter pilot in 1950 could choose between the North American P-51D Mustang and the Supermarine Spitfire LF.Mk 9. Only a few of the latter even had gyro gunsights. In 1959 the best IDF/AF fighter pilots were flying the supersonic Dassault Super Mystère B.2 (SMBD) in daytime, and during the night the DRAC 25A radar-equipped Sud Aviation Vautour IIN night-fighter. In many cases they were the same pilots, and they had to adjust to such revolutionary changes as from piston engines to turbojets, from simple reflector gunsights to sophisticated radar-guided weapon systems, from push-pull controls to hydraulic systems, from the rudimentary parachute to the ejection seat, etc. Not just the IDF/AF, but all the world's modern air forces, faced the same changes between the late 1940s and the early 1960s. To fighter pilots this was the golden age: no-one before them nor after had to master such dramatic technological changes within such a short timescale and such demanding operational requirements.

In early 1950 the IDF/AF was less than two years old. It originated during the Israeli War of Independence which began in May 1948, and emerged as the victor, achieving complete air superiority during the closing stages of the war in December 1948 and January 1949. This was achieved with help from foreign volunteers. As they returned home in 1949-50, the IDF/AF's most urgent need was to fill the ranks of fighter pilots and establish the service's tradition and expertise. The environment at the time was not an ideal one, however. Having exhausted its resources during the country's struggle to survive the 1948-49 war, Israel virtually had to build itself from scratch. At the same time, the population more than doubled as many Jews immigrated to their new homeland, refugees of either the Holocaust in Europe or of hostile Arab regimes in the Middle East. The Israeli armed forces naturally suffered. For example, the IDF/AF's manpower level was restricted to 4,500, and on 1 January 1950 it stood at 4,481.

1950 was the last year in which Aharon Remez commanded the IDF/AF. A World War II RAF flight sergeant, Remez became an air marshal at the age of 28; such were the times. He commanded the IDF/AF from July 1948 and led it through the War of Independence to the inevitable budget cuts ahead. The RAF was his model for the IDF/AF: an independent service. The IDF general staff saw things quite differently, and viewed the air arm just like they viewed the artillery corps. Economy of force, in a poor state such as Israel was in those days, was in favour of the IDF general staff's view. On 17 January 1950 Air Marshal Remez presented his resignation to the Israeli Prime Minister and Minister of Defence, David Ben-Gurion. It was not accepted, yet.

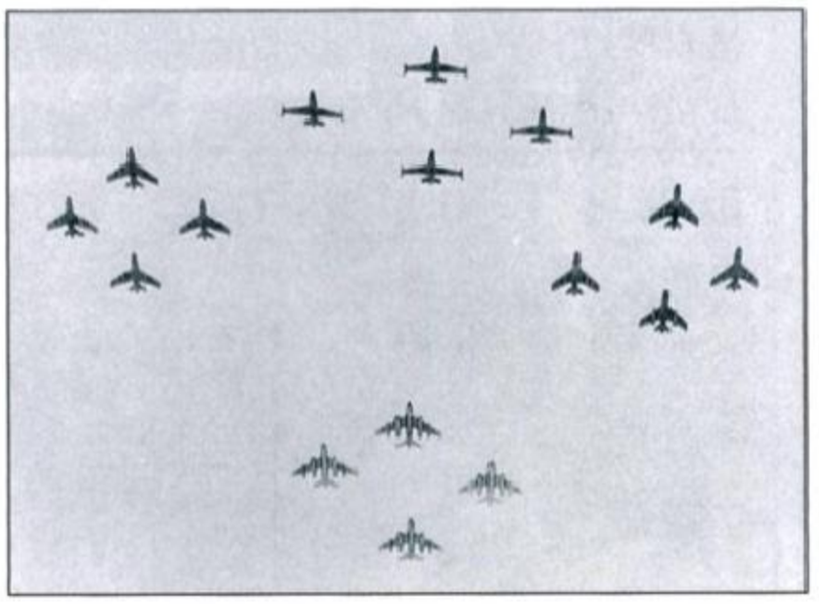
Training organisation

In early 1950 the most urgent requirement of the IDF/AF, apart from modern equipment as described later in this account, was experienced ground and aircrews able to make the most of the equipment already in service. Training, logistic and technical establishments were organised: the Flying School at Sirkin air base (formerly the RAF Petah Tikva Station), 18 Air Depot at Tsrifin (formerly the British army's Sarafend barracks), 21 Technical School at the military zone of Haifa Airport (known initially as Technical Training Base 2) and 22 Air Maintenance Unit at Tel-Nof air base (formerly the RAF Aqir Station). These establishments were also know as wings at various times, e.g. the Wing, 18 Wing and 22 Wing. But this was obviously not enough. Ground and aircrews had to be sent abroad to gain experience with foreign air forces – at first, particularly to the RAF – and with foreign technical establishments, while foreign experts were contracted for service in Israel until the Israeli technical cadre could take over. Hence, circa 1950-51, foreign experts with US citizenship commanded the Air Maintenance Unit at Tel-Nof, the only IDF/AF fighter wing at Ramat-David air base, and occupied key positions in the AMU such as the chief test pilot. Many Italian mechanics were contracted and employed at the AMU due to their cheap cost; Italy was in a deep economic depression following World War II and Italian labour costs were low.

By late 1950 the resignation of Air Marshal Remez was finally accepted and in December he was succeeded by Major General Shlomo Shamir. Although Shamir had a PPL he was an infantry officer who served during the Israeli Independence War as a brigade commander, and was the CO of the Israeli navy before changing the dark blue uniform of the navy for the light blue uniform of the air force. Shamir will be remembered for two minor decisions of major significance. In the first, he replaced the IDF/AF's RAF-style rank system with the general rank system of the IDF/AF. No more *pakad avir* (pilot officer) but a sub-lieutenant, no more *pakad tais* (flying officer) but a lieutenant, no more *pakad teufa* (flight lieutenant) but a captain, no more *rosh tayeset* (squadron leader) but a major, no more *rosh kanaf* (wing commander) but a lieutenant colonel, no more *rosh lahak* (group captain) but a colonel, and no more *aluf avir* (air marshal) but a major general. A small step of great significance. The other decision was to transfer the bureaucratic IDF/AF air staff (known as 111 Sqn) from Jaffa to Ramleh where it was joined by 100 Sqn for liaison duties. Shamir even ordered the transfer of the ground and aircrews of 69 Sqn, 103 Sqn and 109 Sqn – which comprised 4 Wing at Tel-Nof – from their hut accommodation to tents.

Due to health problems Shamir was succeeded in August 1951 by Major General Chaim Laskov, also an army officer who later became the IDF

Above and right: Following swiftly on the heels of the Ouragan was the Mystère IVA which, although remaining subsonic, could nevertheless outfight the Egyptian MiG-15s. 101 and 109 Squadrons operated the type. One Mystère was configured for reconnaissance.



Above: France supplied much of the IDF/AF's equipment in the 1950s. This formation comprises a flight of Ouragans leading Mystères (starboard box) and Super Mystères (port box), with Vautours bringing up the rear.

The Gloster Meteor F.Mk 8 was the IDF/AF's first jet fighter, flying with 117 Squadron. The aircraft were initially delivered with a partially-covered canopy.

The IDF/AF received 30 Ouragans from France as a stop-gap pending delivery of the more capable Mystère IVA. They were used mainly as fighter-bombers, and later for training.

Chief of Staff (CoS) between 1958 and 1961. Laskov continued Shamir's policy of shrinking the air staff and the second-line units, and forging the front-line units. Under the leadership of these two Army officers a compromise finally emerged between the independent RAF-style concept which Remez promoted and the economy-of-force demands by the IDF general staff. The IDF/AF was not to become an independent service but it had its own sort of autonomy within the IDF. In the future, the degree of autonomy would mainly depend on two factors: the IDF/AF's combat successes and the dominant leadership of the IDF/AF CO within the IDF general staff.

Shamir and Laskov paved the way for a fighter pilot to command the IDF/AF. Colonel Dan Tolkowsky was a World War II RAF fighter pilot and an engineer. When he succeeded Major General Laskov in May 1953 he was not promoted to a major general, and remained a colonel for another year before the IDF general staff finally accepted that the IDF/AF could be commanded by someone with an air force background. In May 1954 Colonel Tolkowsky was at last promoted to a major general.

The five years during which Major General Tolkowsky commanded the IDF/AF were a period of expansion, modernisation and accumulation of combat experience, almost in that order. At first Tolkowsky enjoyed the fruits of success of his predecessors, Shamir and Laskov. Shamir inherited from Remez a fighter squadron and a bomber squadron; Laskov passed on to Tolkowsky three fighter squadrons, one fighter-bomber squadron and a bomber squadron. Tolkowsky soon added another fighter squadron and another fighter-bomber squadron, the first of which was particularly significant because it was the IDF/AF's first jet unit. From then on, expansion was directly linked to modernisation, and the 'French Age' dawned for the IDF/AF. By the autumn of 1956 the IDF/AF combat units comprised four jet fighter squadrons and a single reconnaissance squadron, augmented by five emergency units of piston-engined combat aircraft. It was with this force that the IDF/AF fought the Sinai Campaign and obtained its only 1950's combat experience, apart from scattered incidents and operations.

Following the Sinai Campaign the number of jet fighter squadrons was increased to six and only a single emergency piston-engined fighter squadron remained. When Major General Ezer Weizman, also an ex-RAF fighter pilot, succeeded Major General Tolkowsky in 1958 he added another jet fighter squadron to that force. Weizman's contribution went far beyond just that, however. Tolkowsky's period of leadership had stabilised the IDF/AF so that when the flamboyant Weizman took over the IDF/AF was already 10 years old, well organised, combat-experienced and ready to challenge the future. Weizman, with his unique leadership style, coined the slogans *Ha'tovim La'tais* (The Best to Flying) and *Tsionot Be gova 40,000 Regel* (Zionism at 40,000-ft altitude) and insisted on the purchase of as many Dassault Mirage IIIs as possible to serve as multi-role fighters rather than as interceptors. The IDF/AF was finally ready to earn its place in the history of air warfare, and had begun to establish the basis of the worldwide fame it later acquired in the 1960s.

Fighters

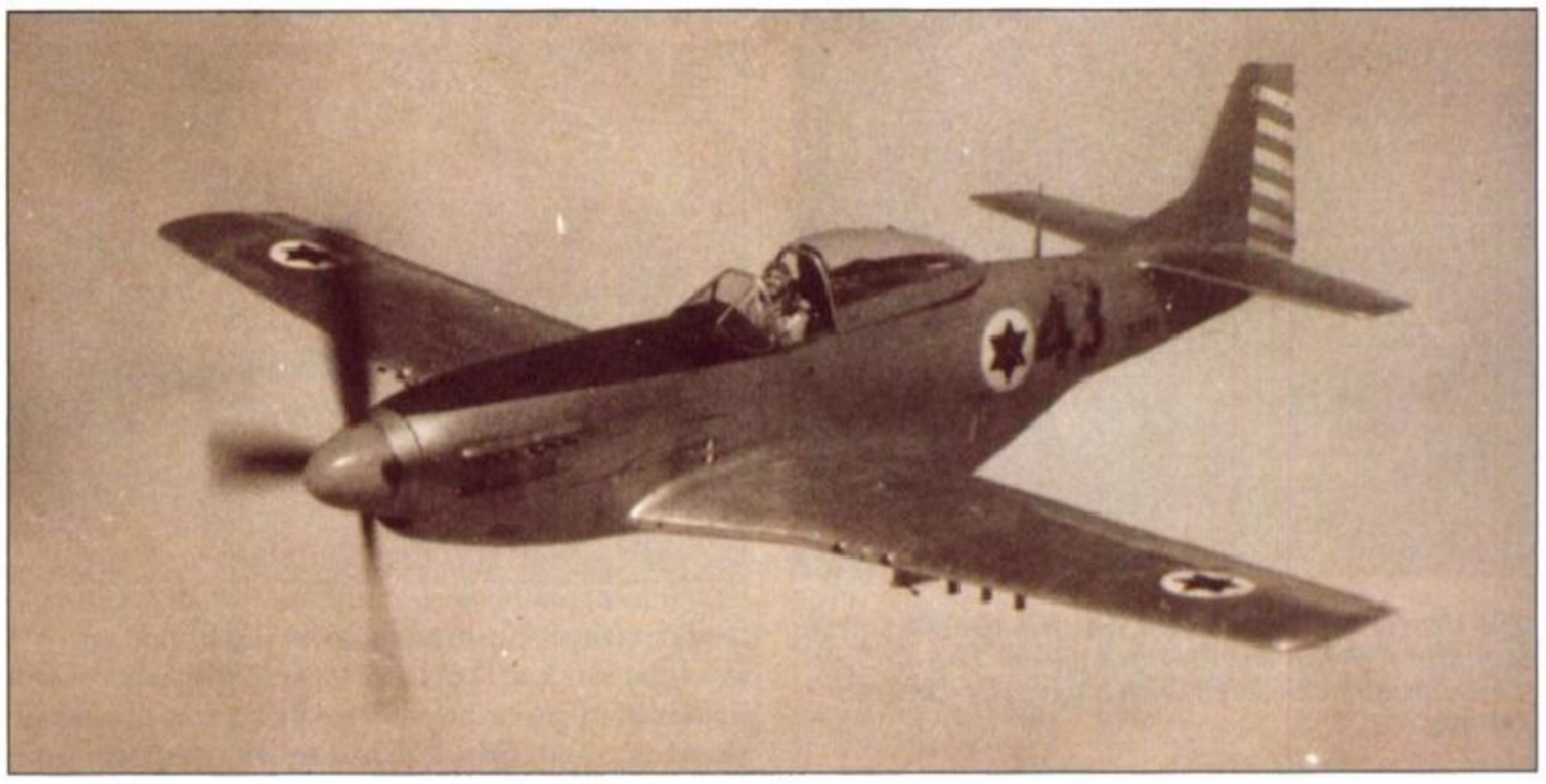
In early 1950 the spearhead of the IDF/AF was still 101 Sqn at Ramat-David. Formed in May 1948, the unit was responsible for achieving IDF/AF air superiority during the final stages of the Israeli Independence War. Two years later it still operated the same Spitfires and Mustangs, but its pilots were far less experienced than the foreign volunteers who had served in 1948–49. In August 1950, when the FS produced its first genuine IDF/AF product in the shape of the

IDF/AF order of battle at 1 January 1950

BASE	UNIT	TYPE
First Line Squadrons		
Ramat-David	101 Sqn	19 Spitfires, 3 Mustangs
	station flight	1 Auster, 1 Piper Cub
Haifa	2 TTB	2 Harvards
Sirkin	Wing	8 Harvards, 4 Stearmans
	141 Sqn	6 Consuls, 3 Ansons, 2 Harvards, 1 Norseman
Tel-Nof	22 Wing	6 Spitfires, 5 Piper Cubs, 5 Rapides, 2 B-17s, 2 C-46s, 2 Harvards, 2 Norsemans, 1 BT-13, 1 Beaufighter, 1 Bonanza, 1 C-47, 1 C-54 1 Hudson, 1 Lodestar, 1 S 199, 1 Stearman (all u/s except 1 Norseman, 1 Stearman)
	69 Sqn	1 B-17
	100 Sqn	10 Piper Cubs, 2 Beech Bonanzas, 1 DH Rapide
	103 Sqn	5 C-46s, 4 C-47s, 2 Hudsons, 1 Mosquito PR.Mk 16

This Spitfire Mk 9, 2001/'10', was the first for the IDF/AF, built up from scrap in 1948. It was used for reconnaissance by 101 Sqn until it was destroyed by a fire in August 1951. In the late 1940s 101 Sqn operated the Mustang and Avia S 199 as well, although none of the latter was serviceable by the start of 1950. S 199s were coded from '01', while Mustang codes started at '40'.

The Mustang remained an important part of the IDF/AF until 1956, flying initially with 101 Sqn and then with 105 and 116.



In early 1951, 101 Squadron standardised on the Mustang, absorbing ex-Swedish aircraft in 1952/53. The Spitfires were reorganised into 105 and 107 Sqns, still based at Ramat-David. The Mustang unit recoded its aircraft from '01' in 1952, and dropped the four-digit serial number two years later.

This Spitfire came from the Italian air force. Most of the batch had full-span wings and rounded tails, as opposed to the pointed fin and clipped wing of the ex-Czech aircraft.

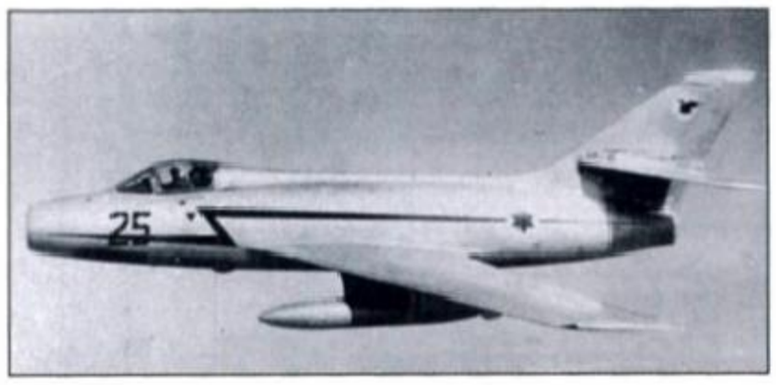
graduates of the 1st Flying Course (FC), an Operational Training Unit (OTU) was organised for the 16 graduates. This effort became the nucleus of 105 Sqn, the second IDF/AF fighter squadron, which became an independent unit in December 1950 when the FS 2nd FC graduated. Early the next year 101 Sqn became a homogeneous Mustang unit and in early 1953 the two Ramat-David-based squadrons were joined by another Spitfire unit, 107 Sqn, which was formed to ease the OTU burden on 105 Sqn.

In June 1953 the Ramat-David fighter wing was further expanded when 117 Sqn was formed as the first IDF/AF jet fighter unit with four Gloster Meteor T.Mk 7s and 11 Meteor F.Mk 8s. After three frustrating years in which the IDF/AF attempted to buy almost every Western jet fighter on the market – from the French Sud Aviation Tritone, via the British Supermarine Attacker to the American North American F-86 Sabre – diplomacy finally triumphed. The British government decided to export 14 jet fighters each to Israel, Iraq, Lebanon and Syria. The contract eventually involved 15 Meteors, an already obsolete fighter but a logical British choice for an introduction to jet fighter operations by the IDF/AF.

Ramat-David fighter wing

About a year later, in February or March 1954, 107 Sqn was disbanded and its personnel and aircraft were amalgamated with 105 Sqn to continue the OTU role. The order of battle for the Ramat-David fighter wing was established for the next two years: 117 Sqn with Meteors, 101 Sqn with Mustangs and 105 Sqn (as the OTU) with Spitfires. Attention then turned south to the creation of the Hatzor fighter wing.

Previously the home of a fighter-bomber wing (which see), Hatzor became in October 1955 the home of the first IDF/AF French fighter unit when 113 Sqn was formed with 24 Dassault Ouragans. The aircraft were delivered in October and November 1955 and were augmented by another six in August 1956. This marked the start of the IDF/AF's 'French Age' which reached its peak in the mid-1960s, when all the IDF/AF fighter units were equipped with French aircraft. The 'French Age' was the result of diplomatic, economical and industrial considerations. France's aviation industry was eager to sell its products, and Israel was eager to buy advanced weaponry to counter the Soviet weaponry which the Arabs acquired from 1955. Both France and Israel were fighting similar enemies: the former was clashing with the Egyptian-supported FLN in Algeria, and the latter was facing Egypt and the other Arab nations in the Middle East. The Suez Canal was obviously another good reason to start a close relationship between France and Israel in the mid-1950s.



Seen right at the end of the decade, this Mystère wears the badge of 109 Sqn at Ramat-David. The fuselage flash was in red.

Aircraft such as this 113 Sqn Ouragan continued to wear Sinai campaign stripes for a time after the end of the conflict. The aircraft is armed with napalm tanks, normally carried by Mustangs.

Right: Many Ouragans received this fearsome marking on the nose around 1956. Camouflage began to appear on the fleet from 1957.

Above: 117 Sqn flew the Meteor F.Mk 8 from 1953 into the 1960s, by which time the aircraft was hopelessly outclassed as a day fighter. A handful of T.Mk 7 two-seaters were also on charge, including a 'T.Mk 7½' built up from Mk 7/8 parts.

Right: Mystères were used initially for fighter purposes, later branching out into attack duties. 101 Sqn was the first to receive the type, marking its aircraft with a thin red fuselage band.

The Ouragan was merely a stop-gap, for it could not challenge the Soviet MiG-15 which was then entering service with the EAF. The Israeli answer was the Dassault Mystère IVA, the first 24 arriving in May to re-equip 101 Sqn at Hatzor. This unit was disbanded as a Mustang operator at Ramat-David in November 1955 and was reformed at Hatzor in April 1956. 107 Sqn was initially reformed as a reserve Mustang unit to succeed 101 Sqn, with Major Eli Eyal as its CO, but this was a short-lived arrangement. It was not, however, the end for the Mustang in IDF/AF service; in fact, instead of one squadron, two units were now to operate the Mustangs. The first was 116 Sqn which was formed at Tel-Nof in February 1956 at the initiative of the new FS CO, Major Itshak Yavneh. Major Yavneh had previously commanded 107 Sqn, 105 Sqn and 101 Sqn and he was the first fighter pilot to command the FS. Until then FS QFIs did not fly operationally, and in an emergency this was obviously a waste. Yavneh's idea was to form an emergency fighter unit staffed by the existing FS manpower; he commanded the unit and his ex-fighter pilot QFIs were the pilots.

Instructor warriors

Less than a year later the idea was validated during the Sinai Campaign, and it was further exploited in the early 1960s by the *Hatzavot Hirum* (Emergency Postings) concept, simply known as *Hatzach* (EPs) for the acronym in Hebrew. Three months later, in May 1956, the Spitfire was finally retired from IDF/AF service when 105 Sqn at Ramat-David converted to the P-51, but still retained its OTU role. This was short-lived as, again at the initiative of Major Yavneh, it was understood that the IDF/AF was becoming a jet fighter force. Major Yavneh claimed that the IDF/AF future fighter pilots would be jet pilots, and he presented to the IDF/AF air staff a worst case scenario: an FC graduate would earn his wings on Harvards, complete the OTU on Mustangs and then, when converting to jets, be unfit to fly them. A classic case of waste of resources. The message was understood and the graduates of the 20th FC in June 1956 were to only ones to receive their OTU on the Mustangs.

In August 1956 another 36 Mystères arrived in Israel, and a month later one more was delivered, equipped for reconnaissance. There were not enough jet fighter pilots to staff the new aircraft, some of which were flown during the Sinai Campaign by French pilots. In December 1956 109 Sqn was reformed at Ramat-David with the Mystères, and at about the same time 105 Sqn was disbanded. The change for which the pilots of 117 Sqn waited so eagerly did not come: the 24 Canadair Sabres which were ordered in 1956 to re-equip the unit were not delivered, and it had to soldier on with veteran Meteors, albeit as the advanced training stage of the FS. Following the Sinai Campaign, Major Yavneh's recommendations were implemented, and the FS graduates earned their wings only after completing the advanced training stage on Meteors at Ramat-David with 117 Sqn. The FC graduates attended the OTU with 113 Sqn. The only piston-engined fighter unit that remained was 116 Sqn at Tel-Nof, manned by staff officers and QFIs for emergency operations. By 1957-58 the IDF/AF fighter community consisted of 109 Sqn with Mystères and 117 Sqn with Meteors at Ramat-David, 101 Sqn with Mystères and 113 Sqn with Ouragans at Hatzor, and the Mustang-equipped 116 Sqn as an emergency unit at Tel-Nof. Three of these units were not fully combat-capable: the FS advanced-training 117 Sqn, the OTU 113 Sqn, and 116 Sqn.

MiG-19s soon appeared across the border so 24 Dassault Super Mystère B.2s were ordered as a stop-gap, pending the purchase of the Mach 2-capable Dassault Mirage III. The type was known in IDF/AF service by its abbreviation of SMB.2 or SMBD (pronounced 'Sambad'). To operate the 'Sambads', 105 Sqn was reformed at Hatzor in August 1958. The IDF/AF fighter force did not undergo another change before the decade was over.

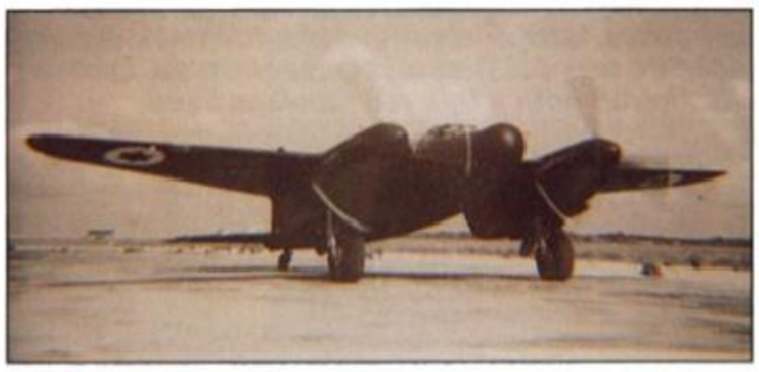
Night-fighters

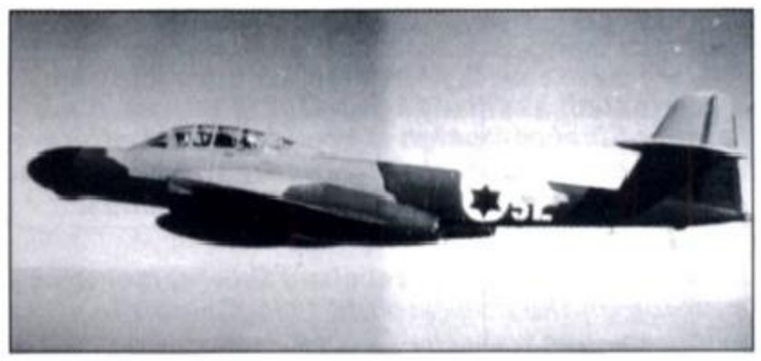
In 1948 Egypt purchased ex-World War II Short Stirling heavy bombers. They were used to bomb Israeli targets at night in late 1948 and early 1949, and were succeeded by the Handley Page Halifax and Avro Lancaster. The IDF/AF had no answer to the EAF's nocturnal bombing

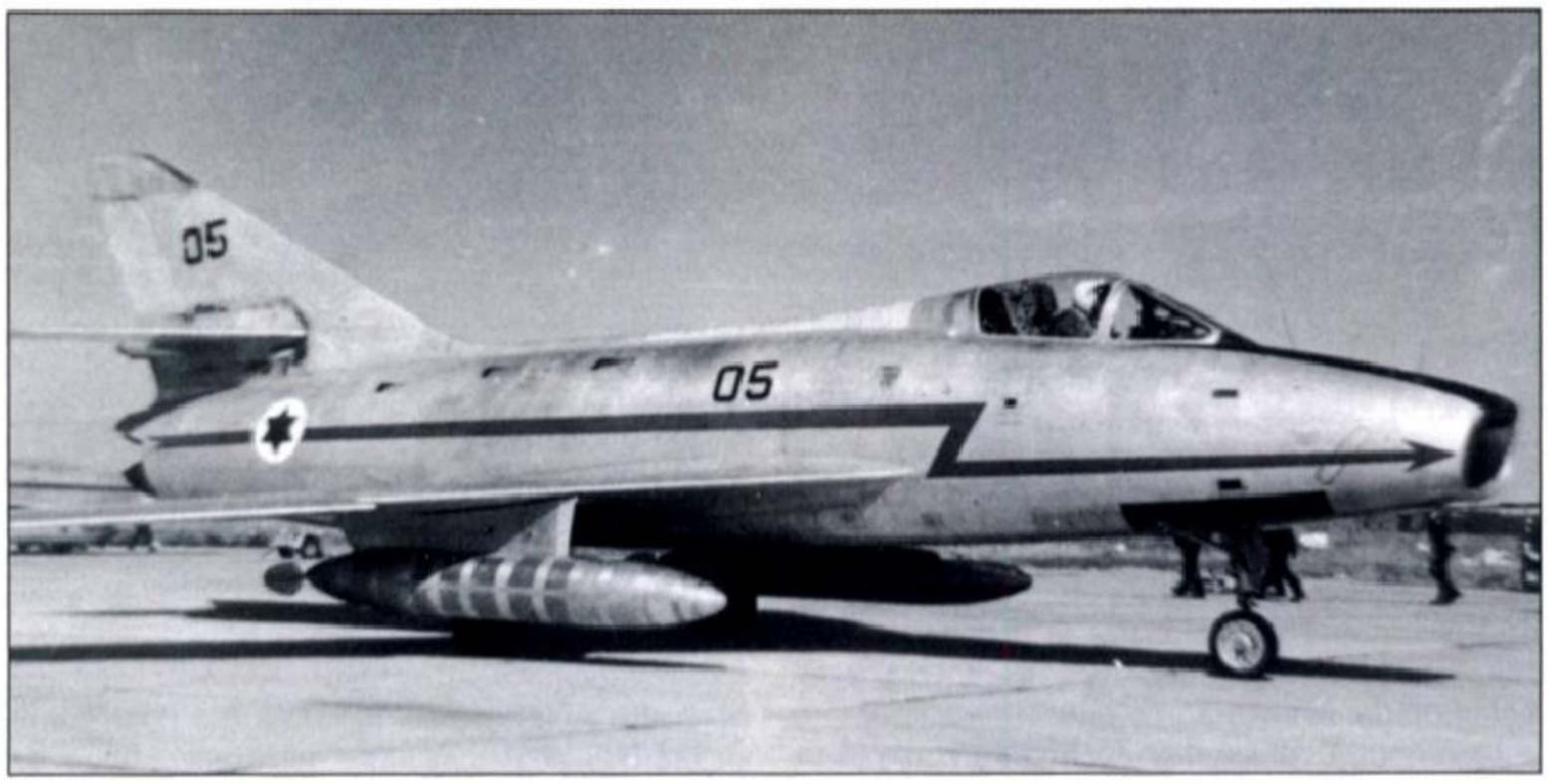
Above and below: Two views show '52', a Meteor NF.Mk 13 of 119 Squadron at Ramat-David. This machine was used to shoot down an Egyptian Ilyushin Il-14 on 28 October 1956. Only five NF.Mk 13s were acquired by the IDF/AF, two of them having been smuggled out of the UK in the face of an arms embargo. During this operation another was lost in France. The NF.Mk 13s were equipped with AI.Mk 10 radar, and served alongside Vautour IINs into the 1960s.

Above: In August 1958 the former Spitfire operator, 105 Sqn, reformed at Hatzor to fly the Dassault Super Mystère B.2, known in Israel as the 'Sambad'.

Right: Nineteen NF.Mk 30s were supplied to Israel as part of the large Mosquito batch acquired from France. These aircraft did not have their original radar fitted, and were not used operationally as night-fighters. The IDF/AF experimented with fitting AN/APS-4 radar.







The Super Mystère B.2 was France's first supersonic fighter, and provided Israel with a potent counter to the Egyptian MiG-19s. This aircraft flew with 105 Sqn.

capability. Although de Havilland Mosquito NF.Mk 30s were among the Mosquitos purchased from France, they were not equipped with their original AI.Mk 10 radars and were never used operationally by the IDF/AF, although tests were carried out when AN/APS-4 radars were fitted. Obviously, the AN/APS-4 was not suited to nocturnal air-to-air interception, but no other option existed.

In 1955 Great Britain continued its 'balanced' policy when it decided to sell six Meteor NF.Mk 13s each to Egypt, Israel and Syria. An integral part of the contract was the training of the IDF/AF aircrews in the art of night fighting. In November 1955 Captain Yoash 'Chatto' Tsiddon and Lieutenant Elyashiv 'Shivi' Brosh attended the RAF 172 AI.Mk 10 course, which commenced on the Bristol Brigands of 238 OCU at RAF Colerne and continued on the Meteor NF.Mk 11s of 228 OCU at RAF Leeming. Graduating in April 1956, Captain Tsiddon and Lieutenant Brosh – the intended CO and senior navigator, respectively, of the first IDF/AF night-fighter unit – had to wait until September of that year before the first two of three Meteor NF.Mk 13s were delivered to the IDF/AF and 119 Sqn formed at Ramat-David. By then the major threat was no longer the piston-engined Lancasters but the jet-powered Ilyushin Il-28, and it was clear that, with the 100-130 km (62-80 mile) range of the IDF/AF ground-based radar stations, the successful interception of the Il-28s by the Meteor NF.Mk 13s was not going to be an easy task. After the Sinai Campaign, 119 Sqn was transferred to Tel-Nof, thereby reducing reaction time against the EAF Il-28s, but a better aerodynamic platform was required to ensure a greater chance of successful interception.

The remaining three IDF/AF Meteor NF.Mk 13s were held by a British arms embargo, but in March 1958 they were smuggled out of England in an operation which resembled the Cherbourg operation of a decade later. Israeli aircrews were despatched to fly the IDF/AF Meteor NF.Mk 13s for refresher purposes, but instead flew them to France, where one crash-landed and was written-off; the other two arrived safely in Israel. The loss of the Meteor NF.Mk 13 was not mourned, however, since a superior night-fighter had been ordered already, in the shape of the Sud Aviation Vautour IIN. The seven aircraft were delivered between April and July 1958 but 119 Sqn continued to operate the Meteor NF.Mk 13s, as well. With its better aerodynamic performance and superior weapon system, the Vautour IIN greatly enhanced the chances of a successful Il-28 interception.

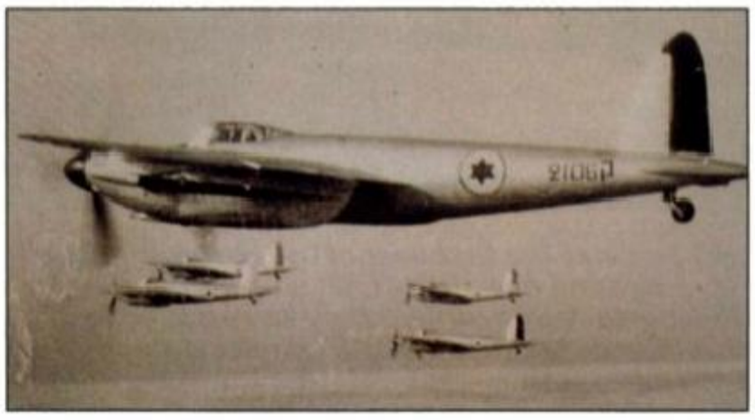
Fighter-bombers and bombers

However small, fledgling and inexperienced the IDF/AF was, it had appreciated from its very inception the potential of a strategic long-range bombing capability. 69 Squadron with its three Boeing B-17 Flying Fortresses was formed at Ramat-David in July 1948. In early 1950 this unit still operated the same threesome of B-17s, albeit from Tel-Nof, as the only IDF/AF bomber unit. It was soon realised that a different type of fighter-bomber was required to bridge the gap between the Spitfires and Mustangs of 101 Sqn and the B-17s of 69 Sqn.

The de Havilland Mosquito was chosen, and over 60 examples were purchased from France, surplus to Armée de l'Air requirements and stored at Chateaudun. The aircraft were purchased

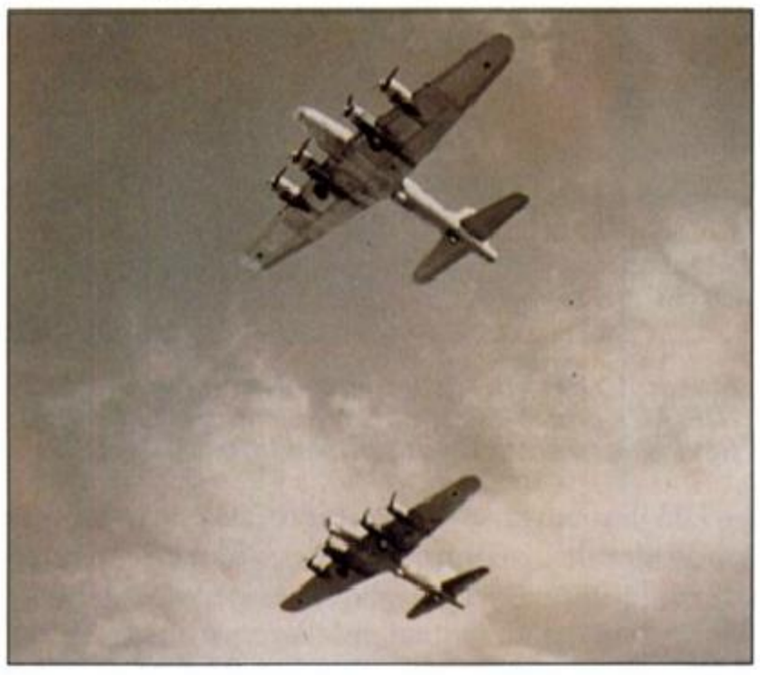
Included in the large batch of ex-French Mosquitos were three T.Mk 3s, resplendent in all-over yellow and identifiable by the slick nose. One more T.Mk 3 was produced in Israel by conversion.

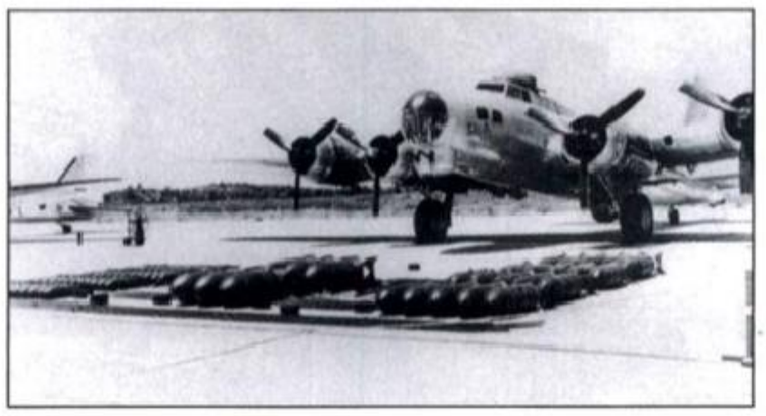
The IDF/AF formed 109 and 110 Sqns to fly the Mosquito fighter-bombers, and reopened Hatzor to house them. The service life of the Mosquito was brief, the last PR.Mk 16 being retired in late 1958 after seeing action over the Sinai.



IDF/AF Mosquito FB.Mk 6s wore the Hebrew character for 'K' after the serial. This indicated Krav (fight) to distinguish the Mk 6 from other variants.

Seven Vautour IIN night-fighters arrived in mid-1958 for 119 Sqn, providing a capable deterrent against Egyptian Il-28 bombers.





Above: At the beginning of the 1950s the IDF/AF's bomber strength consisted of the three B-17s of 69 Sqn. They were configured with three gun turrets and external bomb racks.

Left: Two of 69 Sqn's B-17s are seen together in 1953, one aircraft having had its chin turret removed. The squadron was disbanded in 1954, the aircraft passing to 103 Sqn before retiring in 1955. 69 Sqn was resurrected in 1956 with two B-17s for service in the Sinai Campaign.

without weaponry, communication sets or radars, and had to be rebuilt to operational status. Not all of the Mosquitos purchased were fighter-bombers; the contract included 40 Mosquito FB.Mk 6 fighter-bombers, 19 Mosquito NF.Mk 30 night-fighters, four Mosquito PR.Mk 16 reconnaissance aircraft, and three Mosquito T.Mk 3 trainers. Two Mosquito FB.Mk 6s were later added. The first ex-French Mosquitos arrived in Israel in June 1951.

Mosquito squadron

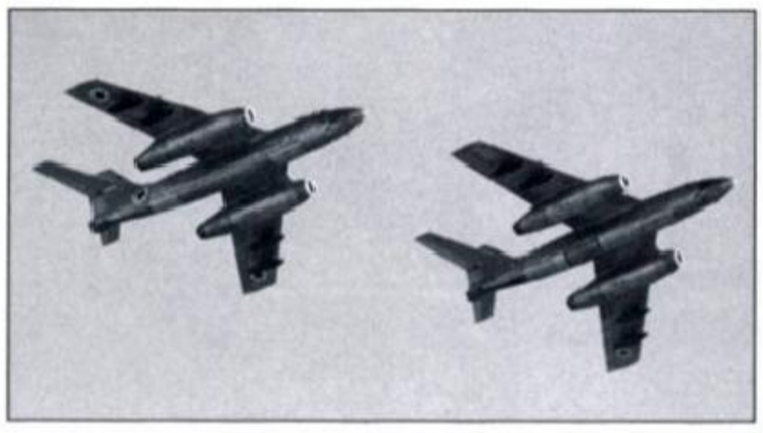
Although 109 Sqn was officially formed at Tel-Nof on 1 July 1951, it did not have an operational capability for quite some time, for this was wholly dependent on the availability of trained aircrews. In fact, the first six 109 Sqn pilots only commenced their Mosquito conversion course with 204 AFS at RAF Swinderby in November 1951. In early 1952 109 Sqn finally achieved IOC at Hatzor, to where it was transferred together with 69 Sqn in late 1951. (Hatzor air base was closed in mid-1949 but two years later it was reopened to house the IDF/AF attack element.) Deliveries of the Mosquitos were completed by late 1952, but expansion of the operational force was dependent on the availability of aircrews rather than aircraft.

The Mosquito was not the ideal aircraft for hot weather operations, and serviceability rates were low, while accidents depleted the inventory and earned the aircraft a questionable reputation. If the IDF/AF had had the benefit of the RAF's experience, it might not have purchased the Mosquito in the first place, although the choice of that type was also a matter of availability. Air Chief Marshall Sir David Lee wrote in his excellent book *Flight from the Middle East* (HMSO 1980, p. 85) about the service of the RAF Mosquitos in the Middle East: "The only aircraft that did not stand up to the conditions well, and there was every reason why it should not, was the Mosquito. It was never designed for long service in excessively hot or wet and humid climates; its deployment to the Middle East and Far East immediately after the war was understandable, and probably inevitable, but it was hardly a fair test for its wooden construction." To the technical staff of the IDF/AF, who had far less experience with the type than the RAF, the Mosquitos posed almost insurmountable serviceability problems. The type developed a bad reputation with both ground and aircrews.

In retrospect one might wonder why the IDF/AF did not build up a force of Mustangs as an alternative to the troublesome Mosquitos, since they had a roughly equivalent range and load performance. It must be remembered, though, that during the Sinai Campaign, as well as in Korea, the liquid-cooled engine of the Mustang proved to be an Achilles heel in the low-level air-to-ground mission.

On 2 August 1953 a second Mosquito unit was finally formed when 110 Sqn joined 109 Sqn at Hatzor. For more than a year the IDF/AF had two fighter-bomber squadrons and a single bomber squadron. In late 1954, 69 Sqn was disbanded for financial reasons and its B-17s transferred to Tel-Nof, where 103 Sqn operated them for one more year before they were withdrawn for storage at Bedek Aviation's facility at Lod International Airport. Further economies, compounded by the high attrition rate of the Mosquitos and the transition to jets, resulted in the amalgamation of 110 Sqn with 109 Sqn in October 1955, although several months later 110 Sqn reformed as a reserve unit to operate (in emergencies) the Mosquitos that were stored at Sirkin. Then, in June 1956, 109 Sqn was disbanded. 110 Sqn followed suit by the end of the year, although it still had a minor role to play in the Sinai Campaign, as did the three B-17s with the resurrected 69 Sqn.

Following the Sinai Campaign, both 69 Squadron and 110 Squadron were disbanded. For more than a year the IDF/AF did not have a true fighter-bomber unit, although all its front-line fighter units had a considerable air-to-ground capability. In January 1958 this shortfall was more

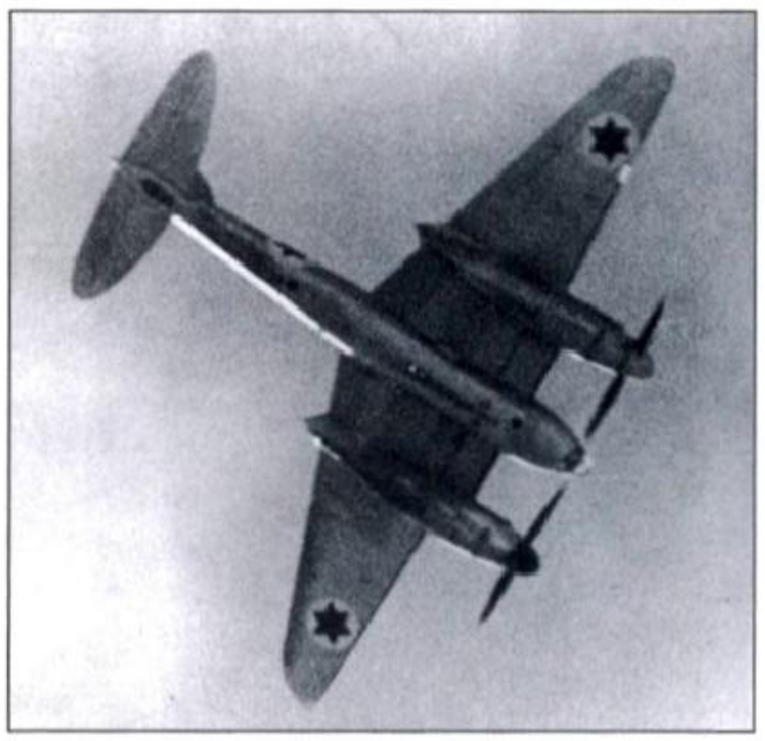


Having previously flown the Mosquito, 110 Sqn was reformed to fly the attack-dedicated Vautour IIA, the first of which arrived at Hatzor in August 1957.

110 Sqn also received four Vautour IIBs, locally converted to IIBR standard for reconnaissance missions. This aircraft crashed at Tel-Nof at the end of its delivery flight but was later repaired.

Mosquito TR.Mk 33s were acquired by the IDF/AF in small numbers. This variant was originally intended as a torpedo carrier, but was used for standard fighter-bomber duties by the IDF/AF.

103 Sqn was the first user of the Mosquito PR.Mk 16, operating one aircraft. When additional machines were acquired they were issued to 115 Flight, part of the Mosquito wing at Hatzor.



Mosquito PR.Mk 16s undertook most of the IDF/AF's photo-reconnaissance effort. The small fleet was eventually organised into 115 Sqn.

than filled when 110 Squadron was reformed at Ramat-David to operate 17 newly acquired Vautour IIA attack aircraft and four Vautour IIB reconnaissance bombers. Delivered between August 1957 and April 1959, the aircraft began to be operated in April 1958. As the decade ended the IDF/AF's heavy attack force consisted of a single squadron, the same as it had in 1950, but with a startling difference in capability.

Reconnaissance and patrol

Only during the 1950s did the IDF/AF have a dedicated reconnaissance unit of manned aircraft. Prior to its establishment, however, economy of force dictated that reconnaissance and patrol duties were performed by regular units rather than by dedicated squadrons. The IDF/AF modified two of the B-17s with an AN/APS-4 radar in place of the nose gun turret so that the aircraft could serve in the dual roles of bombers and maritime patrol aircraft. They were augmented by three PBY Catalinas, the first entering service in 1951, which were operated by 103 Squadron. When 69 Squadron was amalgamated with 103 Squadron in late 1954, all the IDF/AF maritime patrol assets were united – but not for long. In early 1956 the Catalinas were withdrawn from use, and the B-17s followed by the end of that year. The maritime patrol mission was taken over by the C-47s of 103 Squadron, at least two of which were equipped with AN/APS-4 radar, but it is not clear whether this was a trial installation or an operational fit.

103 Squadron's C-47s were also involved in photographic reconnaissance when the aircraft were equipped with oblique cameras and flown along borders to obtain intelligence information. Until the formation of the first Mosquito unit, 103 Squadron was also involved in deeper penetration into enemy territory since it operated the only IDF/AF Mosquito – a PR.Mk 16 which was smuggled from England in July 1948. Deeper penetrations were also performed by the reconnaissance Spitfires, which were locally converted rather then dedicated PR versions. They were operated by 101 Squadron until April 1951, when 105 Squadron achieved IOC and accepted responsibility for the reconnaissance Spitfires. In May 1952 the Mosquito PR.Mk 16s of 109 Squadron joined the IDF/AF's operational PR community when the first operational reconnaissance missions over enemy territory

Israel Defence Force/Air Force Chronology 1950-59

1950

1 January The Flying School formally opened at Sirkin air base, then known as Alon Base after the legendary first commander of 101 Sqn, Mordechai Modi Alon, who was killed when his Avia S 199 crashed on 16 October 1948. The FS composed of 138 Sqn with Stearmans for primary training, 140 Sqn with Harvards for basic training and 114 Sqn with Ansons and Consuls for multi-engine training and the training of navigators and wireless operators.

10 January 111 Sqn was formed as the IDF/AF AHQ, then still based at Jaffa.

16 January Air Defence Command formed with Colonel Boris Senior as CO. By the end of the year it was disbanded; the early warning components became an element of the IDF/AF, and the AA regiments were integrated into the IDF Artillery Corps.

February The Fokker S.11 was selected as the future IDF/AF primary trainer after a competitive evaluation against the DHC-1 Chipmunk. The latter arrived in Israel by ship on 9 December 1949, followed by the S.11 which arrived in flight on 16 December 1949. The Temco T-35 arrived in crates on 23 May 1950. The FS chief instructor's evaluation report of the T-35 was published on 27 June 1950 but did not change the decision to purchase the S.11.

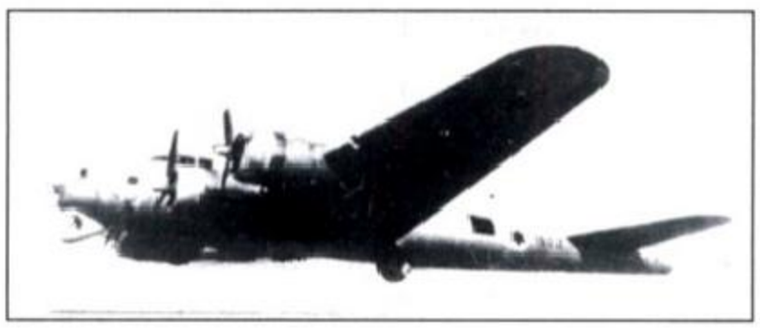
9 March A Flight Test Unit was formed within 22 Wing. The first chief test pilot was Seymour Feldman, an American who had flown with the RAF between 1942 and 1948. He was awarded a DFC in July 1944 after he shot down 11 V-1 flying bombs.

10 August The FS 1st Flying Course graduation ceremony. Among the 13 graduates was Yehezkel Somech, a future Mosquito squadron CO, Vautour squadron CO, Ramat-David air base CO and IDF/AF deputy CO.

December 105 Sqn was formed at Ramat-David air base with Captain Menahem Bar as CO. Equipped with Spitfires, the second IDF/AF fighter unit was primarily an OTU, a direct result of the graduation of the first FS flying course. It began to operate within 101 Sqn in August but was formally separated as a new squadron in December.

103 Squadron was the IDF/AF's principal transport squadron, although it also flew other missions. The main aircraft in use were the Curtiss C-46 and Douglas C-47, seen here together. 103 Sqn had a reconnaissance tasking, for which it used a single Mosquito PR.Mk 16 and camera-equipped Dakotas.

Three PBY-5A Catalina amphibians flew coastal patrols with 103 Squadron. They flew from 1951 to 1956 before being retired.



1602 was one of the two B-17s fitted with AN/APS-4 radar for patrol work with 69 and then 103 Sqn. They retained the bombing mission.

The Hiller 360 was the IDF/AF's first helicopter type, serving with 100 Sqn at Ramle from 1951 to 1956 in the liaison and observation roles.

The Piper Cub and Super Cub (illustrated) were the workhorses of 100 Sqn through the 1950s. They were used for a wide variety of tasks, including border patrol.

were flown. They were mainly short-range incursions, and the value of deep-penetration reconnaissance was only demonstrated in September 1953 when in two missions, on successive days, a Mosquito PR.Mk 16 photographed first Alexandria and then Cairo. In July 1954 the reconnaissance activity of the Mosquito PR.Mk 16s was established when 115 Flight was formed at Hatzor with the two fighter-bomber Mosquito squadrons. The Mosquito PR.Mk 16s continued to photograph the Middle East until 1956, when 115 Flight was transferred to Tel-Nof, became 115 Squadron and was augmented by another three Mosquito PR.Mk 16s in late 1956.

Jet reconnaissance was introduced in 1956, initially in the shape of Meteor T.Mk 7s which were converted for reconnaissance and attached to 115 Squadron. A dedicated reconnaissance Mystère arrived in September 1956 to resurrect the PR capability of 101 Squadron, which had been lost when the Mustangs were withdrawn (some of the Mustangs were F-6s and had been used for oblique reconnaissance along the borders). Then 115 Squadron, the only dedicated manned aircraft reconnaissance unit of the IDF/AF ever to exist, was disbanded. By the end of the decade the IDF/AF reconnaissance assets included the reconnaissance Mystères of 101 Squadron, which in August 1957 photographed Cairo West air base; the four Vautour IIB reconnaissance bombers of 110 Squadron, which were locally converted to Vautour IIBR standard and really started to earn their keep during the 1960s; and the C-47s of 103 Squadron, which were still used on oblique photography missions.

Support

Throughout most of the 1950s the IDF/AF's airborne support elements included just two units. The first, 100 Squadron, was formed in 1949 by the unification of 1, 2 and 3 Squadrons, which were the sectorial liaison units that operated throughout the 1948-49 war. By 1950 the unit had standardised on the Piper Cub, but it also still had many other aircraft types – including Rapides and Bonanzas – as a memory of the hard days of 1948-49 when it struggled to survive. The Piper Cubs were used for liaison, observation, border patrol, casualty evacuation and even attack, with two 0.303-in machine-guns attached to the wings just outboard of the wing struts. In 1951 the unit received the first IDF/AF helicopter, a Hiller 360, which was joined the next year by a second example. The Hillers could not challenge the Piper Cubs, but in late 1956 the latter type's replacement began when the first Piper Super Cubs arrived. Another type of aircraft operated by 100 Squadron at that time was the Fokker S.11. The S.11s had been a failure in the primary training role with the FS, but the examples that were passed on to 100 Squadron in 1953 were soon retired since the type obviously was not suited to the unit's liaison and observation missions.

1956 also witnessed the departure of the remaining Hiller from 100 Squadron, the result of the purchase of two Sikorsky S-55 helicopters.

14 December The FS 2nd Flying Course graduation. Among the 21 graduates was Binyamin Peled, IDF/AF CO from 1973-77.

14 December General Shlomo Shamir succeeded Air Marshal Aharon Remez as IDF/AF CO. As a result the AHQ, 111 Sqn, was transferred from Jaffa to Ramleh and the unique IDF rank system, in the style of the RAF, was replaced by the standard IDF/AF rank system.

1951

5 April Four 101 Sqn P-51s and four 105 Sqn Spitfires attacked Syrian strongpoints at El Hama as a retaliation to the killing of Israeli 'policemen' (IDF soldiers wearing police uniforms) in that area.

12 April The FS 3rd Flying Course graduation. Among the nine graduates was Aharon Yoeli who earned his fame on 1 September 1955 (which see).

May The first IDF/AF helicopters, two Hiller 360s, arrived by ship from the US.

6 May Four 105 Sqn Spitfires on a routine OTU training flight were called to support the hard-pressed IDF ground forces at Tel-Motila on the Syrian front. Following numerous dummy strafing passes, during which one pilot actually fired his 20-mm cannon, in the face of heavy Syrian AA fire all four Spitfires were damaged, but the attacking Syrian forces retreated and a senior IDF officer stated "it was the day of the air force!"

15 May Gadna Avir (Air Cadets) was formed to train youth as a future IDF/AF human resource. The youth at first built balsa models, then flew gliders and, finally, the best received a short flying course on Piper Cubs with 128 Sqn at Sde Dov.

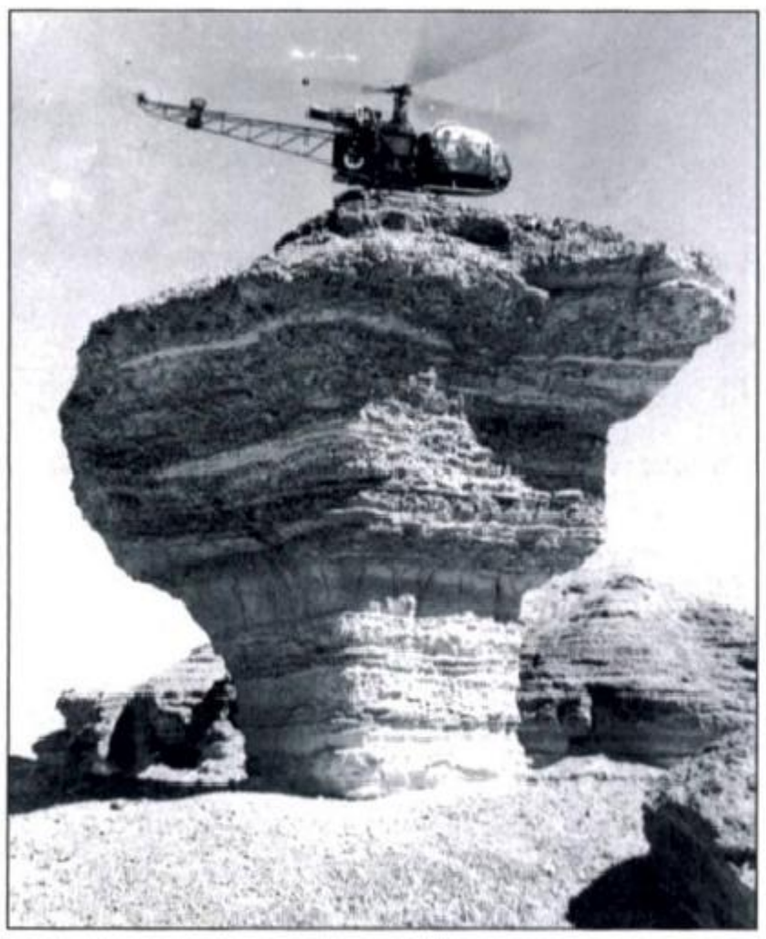
12 June First three ex-French air force Mosquitos arrived in Israel. Thirty-six had arrived by December 1951 and a further 21 by November 1952.

1 July 109 Sqn, the first Mosquito unit, formed at Tel-Nof air base with Captain Daniel Shapira as its CO. In October the squadron was transferred to the reopened Hatzor air base.

11 August Major General Chaim Laskov succeeded Major General Shamir as IDF/AF CO.

14 August The FS 4th Flying Course graduation. Among the graduates was Ya'acov Agasi, later known as Israel's 'Mister Vautour' who commanded a Vautour squadron between 1959 and 1963 and was twice the Ramat-David air base CO.

27 December The FS 5th Flying Course graduation. Among the graduates was Ya'acov Nevo, the first IDF/ AF air-



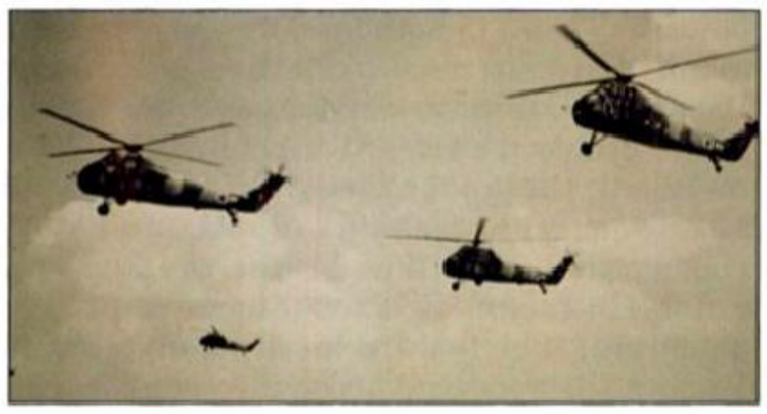
'03' was the IDF/AF's first Alouette II, donated by a French widow and acquired in 1957. The aircraft carried the inscription 'God Will See' at the behest of Madame Deutsch de la Meurthe.

Above: In February 1958 three Sikorsky S-58Bs were delivered to Israel, allowing the IDF/AF to embrace new ideas of air mobility. The aircraft were assigned to 124 Sqn at Tel-Nof.

That type deserved the description of transport helicopter rather then liaison helicopter, so all the IDF/AF helicopters were transferred to the newly formed Helicopter Flight within 103 Squadron at Tel-Nof. The latter unit was the only IDF/AF transport unit throughout the decade. In 1950 it operated the Curtiss C-46 Commando and the Douglas C-47 Skytrain, but the former were little used and gradually transferred to the national airline, El-Al.

Versatile Dakota

Between 1950 and 1955 the IDF/AF transport unit operated the ubiquitous C-47 for a variety of missions ranging from transport to crop spraying. It seemed like the IDF/AF would not purchase a new transport aircraft for many years, but commercial considerations of the French aircraft industry came to the aid of the transport aircrews. As a part of the first Ouragan contract Israel was obliged to buy three Nord 2501 Noratlas transports, which were delivered to 103 Squadron in late 1955 and early 1956. Another French contribution was the loan of 10 C-47s for the Sinai Campaign. Satisfaction with the twin-boomed French transport resulted in the purchase of another five – two arrived in 1957, two in 1958 and one in 1959. No significant changes affected 103 Squadron until the end of the decade, except for the upgrade of the helicopter flight's status to a separate squadron.



Right: The Sikorsky S-55 was taken on charge in 1956, initially serving with 103 Sqn Helicopter Flight before transfer to 124 Sqn. This example is seen lifting a mortar.

Below: By the end of the 1950s the S-58 was established as 124 Sqn's main transport helicopter. Sizeable heliborne air assaults were now possible.

In July 1957 the IDF/AF received as a donation from a wealthy French widow a single Sud Aviation Alouette II, and the first Sikorsky S-58 helicopters arrived in Israel in February 1958. The resulting increase in rotary-wing aircraft allowed the formation of a separate helicopter squadron, and 124 Squadron was formed at Tel-Nof on 1 January 1958. The next year the IDF/AF air staff was transferred from Ramleh to Tel-Aviv and 100 Squadron was transferred to Sde-Dov, where it had originated a dozen years earlier.

Below: Another photograph of '03' shows the Alouette II engaged in an air-sea rescue exercise. The S-55 and S-58 were also winch-equipped for rescue work.

to-air combat artist, and Yael Finkelstein (Rom after her marriage), a pilot.

1952

17 February Contract signed for the purchase of 30 ex-Italian air force Spitfires. Aircraft refurbished by Ambrosini and flown to Israel.

24 April The FS 6th Flying Course graduation. Among the nine graduates was Uri Yarom, the IDF/AF rotary-wing flying pioneer.

14 August The FS 7th Flying Course graduation. Among the 12 graduates was Eldad Paz, who had to walk more than 60 km in 37 hours back to the Israeli lines during the Sinai Campaign of 1956 after his Mustang was shot down at Sinai.

9 October The FS 8th Flying Course graduation. Twelve graduates.

1953

5 February The FS 9th Flying Course graduation. Twelve graduates.

18 February Captain Itshak Yavneh was appointed as the first 107 Sqn CO. The new squadron was formed with Spitfires at Ramat-David air base to share the OTU burden with 105 Sqn.

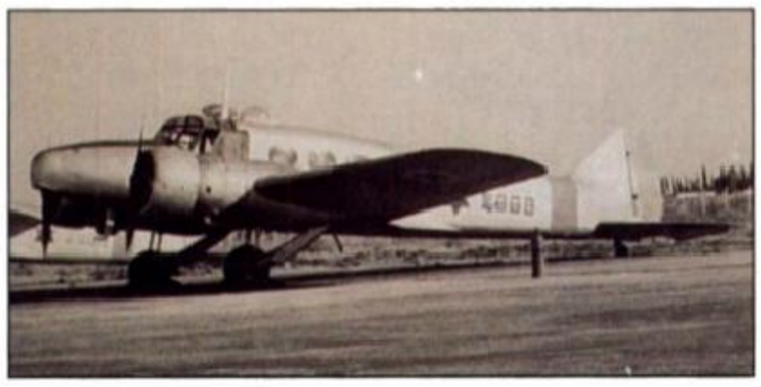
8 April The FS 10th Flying Course graduation. Seven graduates.

5 May Colonel Dan Tolkowsky succeeded Major General Laskov as IDF/AF CO. Only in May 1954 was Colonel Tolkowsky promoted to a major general.

7 June 117 Sqn formed at Ramat-David air base with Major Menahem Bar as CO. It was the first IDF/AF jet fighter unit.

17 June The first IDF/AF jets, two Meteor T.Mk 7s, arrived in Israel. Deliveries of the 11 Meteor F.Mk 8s and four Meteor T.Mk 7s were completed by January 1954.

2 August 110 Sqn formed at Hatzor air base as the second Mosquito unit with Major Hugo Marom as CO. As an illustration of the IDF/AF shortage of



Providing navigator training during most of the decade was the elderly Avro Anson Mk I, which served at Sirkin with 141 Squadron.

Above: From 1955 eight Nord 2501 Noratlas transports were delivered to 103 Sqn. In addition to the primary role they were also used for patrol work.

Left: A scene at Tel-Nof depicts 103 Sqn Noratlases and Dakotas. The Dakota was used for many years as an oblique photography platform.

By the end of the decade, IDF/AF support elements included three squadrons. Equipped with Piper Super Cubs and based at Sde-Dov, 100 Squadron's main missions were liaison and observation. 103 Squadron, based at Tel-Nof, operated the C-47s and Noratlases for duties such as transport, maritime patrol, communication relay, and oblique photography. The co-located 124 Squadron operated its S-55, S-58, Alouette and Hiller helicopters mainly for assault, transport and casualty evacuation.

Training

The most urgent requirement of the IDF/AF in 1950 was the production of its own cadre of pilots. As a result, the first major purchase programme following the end of the Israeli War of Independence in 1949 was not of combat aircraft but of a primary trainer. An example of each of the three types that were evaluated – the Vultee T-35, the DHC-1 Chipmunk and the Fokker S.11 Instructor – were purchased and shipped to Israel for a comparative trial. The Fokker aircraft won and another 40 were ordered, but it proved to be a complete failure.

The Flying School (FS) was formally opened at Sirkin on 1 January 1950. It was basically a fighter pilots' school. All of its graduates were expected to become fighter pilots and were streamed directly to the OTU, chiefly with 105 Squadron at Ramat-David. Only those students who were found unfit to fly single-engined fighters would convert to multi-engined aircraft or, paradoxically, become Qualified Flying Instructors (QFIs) with the FS. At least until 1956, when Major Itshak 'Tsahik' Yavneh took charge of the FS, and during the period of his successor Lieutenant Colonel Yesha'ayahu 'Shaya' Gazit, many of the FS's QFIs were not fighter pilots, yet it was a fighter pilots' school! Lightplane pilots were trained separately by 100 Squadron and were not commissioned as officers.

The Flying Course (FC) consisted of two main phases: primary training on Stearmans with 138 Squadron and basic training on Harvards with 140 Squadron. Ansons and Consuls were provided by 141 Squadron for multi-engined aircraft training courses and for the training of navigators and wireless operators. In 1950 the primary training squadron CO was Pakad Tayis (Flying Officer) Yesha'ayahu 'Shaya' Gazit and the basic training squadron CO was Pakad Tayis (Flying Officer) Israel 'Tibi' Ben-Shachar, both of whom had graduated their own FC – which began in Italy in May 1948 and continued in Czechoslovakia until December 1948 and then with 101 Squadron in Israel – on 14 March 1949! About a year after obtaining their own wings they became the commanding officers of the FS training squadrons.

To obtain more experience, several QFIs attended a flight instructors' course with the RAF. The first to go, in 1950, was Israel

IDF/AF order of battle at 29 October 1956 (serviceable aircraft only)

BASE	UNIT	TYPE
Ramat-David	69 Sqn	2 B-17s (emergency reserve unit)
	105 Sqn	13 Mustangs (unit about to be disbanded)
	110 Sqn	13 Mosquito FB.Mk 6s, TR.Mk 33s (emergency reserve unit)
	119 Sqn	2 Meteor NF.Mk 13s (forming with just one crew)
	199 Sqn	18 Mystères (French unit flying French aircraft)
	201 Sqn	12 Mystères (French unit flying IDF/AF aircraft)
Ramle	147 Sqn	25 Stearmans (FS primary training squadron, normally based at Tel-Nof)
Lod	200 Sqn	18 F-84Fs (French unit)
Tel-Nof	103 Sqn	3 Noratlases, 16 C-47s
	115 Sqn	3 Meteor T.Mk 7s, 2 Mosquito PR.Mk 16s
	116 Sqn	16 Mustangs (staffed by FS QFIs)
	117 Sqn	11 Meteor F.Mk 8s, FR.Mk 9s (normally based at Ramat-David)
Hatzor	101 Sqn	16 Mystères
	113 Sqn	22 Ouragans
Be'er Sheba	100 Sqn	11 Piper Cubs (normally based at Ramle)
	140 Sqn	17 Harvards (FS basic training squadron, normally based at Tel-Nof)
Eilat	100 Sqn	4 Piper Cubs (a detachment)

experienced aircrew and leaders at that time, Marom had graduated the FS first flying course exactly three years earlier. No such meteoric promotion is possible in the current IDF/AF.

13 August The FS 11th Flying Course graduation. Ten graduates.

3 September The IDF/AF's first daring deep penetration reconnaissance mission was flown by Lieutenant Colonel Shlomo Lahat and Major Nathan Eldar in a Mosquito PR.Mk 16 when they photographed Alexandria. The next day they photographed Cairo.

8 September The FS 12th Flying Course graduation. Ten graduates.

1954

February 107 Sqn disbanded at Ramat-David. Most of its aircraft and manpower were amalgamated with 105 Sqn by the next month.

25 February The FS 13th Flying Course graduation. Among the 14 graduates was Rafael Har-Lev, a future Ouragan squadron CO, Mirage squadron CO and IDF/AF deputy CO. He was the CEO of El-Al, the Israeli national airline, from 1982-96.

3 June The FS 14th Flying Course graduation. Among the 12 graduates was David Ivry, a future Mystère squadron CO, Mirage squadron CO and IDF/AF CO from 1977-82. He was the CEO of the Israeli Ministry of Defence from 1986-96.

8 July 115 Flt formed with Mosquito PR.Mk 16s at Hatzor with Captain Azriel Ronen as CO. The first IDF/ AF dedicated reconnaissance unit, it became 115 Sqn in June 1956.

August First ex-IDF/AF combat aircraft export when Burma bought 30 Spitfires.

23 August The FS 15th Flying Course graduation. Six graduates.

October First of 14 ex-FAA Mosquito TR.Mk 33s arrived in Israel. Deliveries were completed by June 1955.

1 December 69 Sqn amalgamated with 103 Sqn as 103 Sqn at Tel-Nof air

For most of the 1950s the Boeing Stearman 75 provided primary pilot training for the IDF/AF. Towards the end of the decade the aircraft received camouflage.

Above: The elderly Airspeed Consul was put to good use by 141 Sqn as a multi-engined pilot trainer. In 1950 six were in use, operating from Sirkin alongside three Ansons.

Above and left: The Fokker S.11 won the IDF/AF primary trainer contest but proved to be a failure in service largely due to its fragile undercarriage. Shown above is the first IDF/AF S.11, which was the only one of the three competitors to fly to Israel, arriving on 16 December 1949. The others arrived by ship. In 1953 the S.11s were withdrawn from use as trainers, although they continued with 100 Sqn until 1955/56. Such was the IDF/AF's disappointment with the S.11 that many remained unassembled in their crates.

Ben-Shachar, who relates: "In the autumn of 1950 I was on vacation when I got a phone call to report immediately to AHQ. They told me to get well dressed and go to England. I was in the first group to go to England and there was no-one I could ask about how to behave. I hardly knew English but I had learned enough to get by from the Americans at 101 (Squadron). Since I had previous experience as an instructor, and I was able to handle the Harvard well, I felt pretty much at home. The flight instructors' course was at the CFS at Little Rissington near Oxford. Of the 49 or 50 men who attended the course with me, there were only three foreigners: me and two FAA pilots. On the other courses – each month, a four-month long course started, so there were four courses running in parallel – there were pilots from Egypt, Iraq, Lebanon, Pakistan, France, Denmark, from all over the world.

"My instructor was an ex-World War II bomber pilot, Johnny Green, and right from the start he made a deal with me: 'you will teach me aerobatics and I will teach you instruments.' I loved aerobatics, and everything went well. Suddenly I noticed that Johnny Green was neglecting me and I was flying with the instructors of the Flying Examining Wing. It turned out that they watched me, they noticed that I was flying in a different style. It was precise flying; I was pretty daring, too, and I had a wide spectrum of exercises which they did not know. For example, there was an exercise which I learned from Augarten (an ex-USAAF 101 Squadron fighter pilot). The USAAF called it rudder exercise. If you stalled the Harvard it had the habit of dropping a wing and entering a spin, but you could prevent it spinning by very, very quick rudder reactions until slowly, slowly the nose dropped. If you succeeded, you won; if not, oh dear, you entered an inverted spin. This exercise helped me a lot when I had students with slow reactions; with that exercise, at high altitude, I taught them to be quick and feel the aircraft.

"The Harvard was very kicky on take-off and

base to operate the B17s, C-47s and Catalinas.

23 December The FS 16th Flying Course graduation. Among the 15 graduates was Amos Lapidot, a future Ouragan squadron CO, Mirage squadron CO and IDF/AF CO from 1982-87.

1955

January Deliveries of nine Meteor FR.Mk 9s commenced and completed by May 1955.

1 January 147 Sqn formed as The FS basic training squadron with Harvards.

5 May The FS 17th Flying Course graduation. Among the 12 graduates were Giora Forman and Aharon 'Yalo' Shavit. The former became an IDF/AF deputy CO and the latter was to earn his fame when he shot down two EAF Vampires on 31 October 1956 as a young Mystère pilot. He later added to his personal score an SAF MiG-21 on 5 June 1967, while a Super Mystère squadron CO.

4 August The FS 18th Flying Course graduation. Nine graduates.

20 August First jet-versus-jet air-to-air engagement in the history of the Middle East air warfare. Two IDF/AF Meteors engaged four EAF Vampires, but neither side was successful.

1 September Captain Aharon Yoeli of 117 Sqn shot down two EAF Vampires over Israeli territory in a Meteor FR.Mk 9. They were the IDF/AF's first jet kills and the first of over 100 kills to be claimed by 117 Sqn.

4 October 113 Sqn with Ouragans formed at Hatzor with Captain Binyamin Peled as CO. Twelve Ouragans were delivered to the unit in October followed by a dozen in November. Six pilots were converted in France in September and the first 113 Sqn Ouragan conversion course, for a further 10 pilots, commenced on 7 November. IOC was achieved in December.

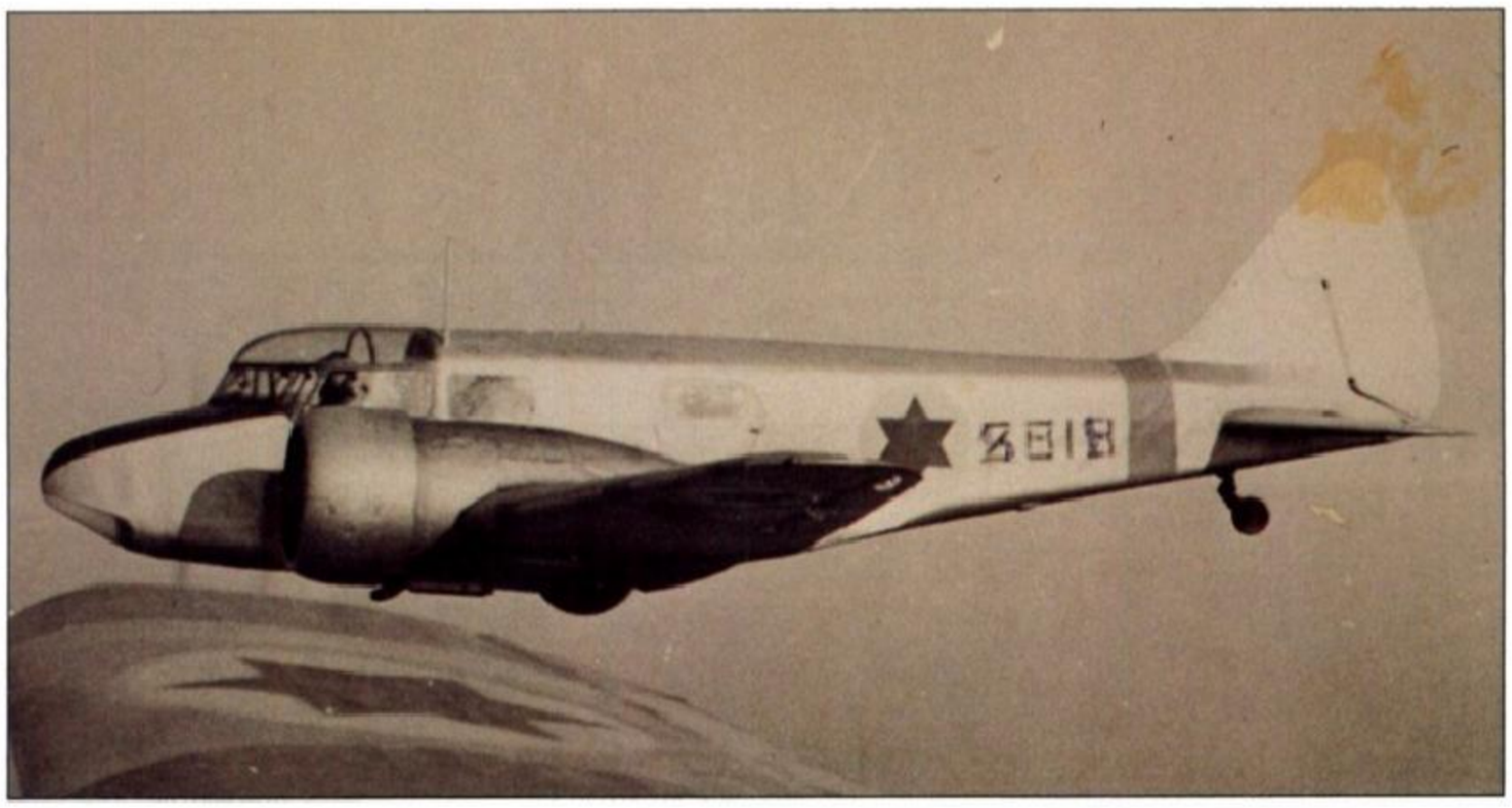
6 October Ouragan deliveries commenced when the first six arrived in Israel. By November 24 were delivered, and another six were accepted in August 1956.

November 101 Sqn disbanded as a Mustang unit and was succeeded by the short-lived 107 Sqn. The latter was reformed as a Mustang reserve unit, with Major Eli Eyal as the CO.

1 November First Noratlas arrived in Israel. Another two were delivered in 1956, two in 1957, two in 1958 and one in 1959.

1956

5 January The FS 19th Flying Course graduation. Eleven graduates.



The Consul served in the multi-engine training role until the late 1950s. Its partner in 141 Squadron was the Avro Anson, which flew the navigator training mission until modified three-seat Harvards adopted the mantle. Note the crude attentions of the IDF/AF censors to the serial number.

At the end of 1949 the IDF/AF acquired one example each of the Fokker S.11, de Havilland Canada Chipmunk and the Vultee T-35 for a fly-off evaluation. This is the Chipmunk, which later became a private aircraft owned by a Bedek Aviation employee.

landing; if you were not careful either you rolled off the runway on take-off or did a ground loop on landing. I had some 1,500 Harvard back-seat instruction flying hours without a single ground loop, despite the situations my students sometimes got me into!

"Another exercise I knew was the emergency landing exercise. The procedure was to enter base leg at 1,200-1,500 ft, and turn at 800 ft so that at 500 ft you level your wings and either succeed (to land) or not. That was the procedure we inherited from the British. I learned from Dangott (an ex-US Navy 101 Squadron fighter pilot) how to land on an aircraft-carrier: you came on dead leg and from there you turned 360°, descending all the time. It was a so-called fighter approach and I turned it into an emergency landing exercise.

"The British did not know the chandelle or the lazy eight, which are great exercises to improve co-ordination. I did the slow roll at four stages, eight stages, and even 16 stages.

"But I also learned a lot from the British. I learned the value of an educated pilot. Every briefing, every exercise, every debriefing was thorough and based on theory, not theory for its own sake but the application of theory to practical flying. For example, prior to stalling or spinning the student understood why the aircraft would stall, why the aircraft would spin. You must connect theory and practical flying.

Fellow students

"The course was very serious, very thorough. It was the first time that I really had ground school as it should be, four months, half a day every day. I've kept my notebook to this very day. I even have some Arabic written in it, from an Iraqi major who volunteered to teach me SB, Standard Beam approach. He was the chief instructor of the RIrAF, but he was dumb, and he had already been at that school for a year because the British did not dare to send him back home. They wanted to teach him something, so they put him on another course and another course and another course. I also got friendly with an Egyptian, Hezi Yosuf was his name, and there was another Egyptian, also dumb, Mohamed Ramadan. One day his instructor asked me if I spoke Arabic, and I replied that I could only curse. He asked me what 'Ya Allah, Ya Allah' meant, so I told him it was 'my God, my God'. He said, 'Listen, whenever I take this guy up to teach him aerobatics, I just cannot send him alone. When he reaches the top, with his head upside down, he takes his hands off the stick and cries, 'Ya Allah, Ya Allah!'.'

"The highlight was when the Flying Examining Wing's instructors flew with me at the recommendation of my instructor. At the end of every course there was an aerobatics contest, and I won first prize. It was a revolution. When I arrived they treated me like a native."

Primary training on the Stearman was initially undertaken at Sirkin, but was later established at Tel-Nof. Here a 6th Flying Course cadet demonstrates a perfect three-pointer.

The graduates of the IDF/AF's 1st and 2nd FCs were not genuine IDF/AF products, for they had commenced their training in Czechoslovakia in 1948. Beginning with the 3rd FC, the FS began to produce a steady stream of future fighter pilots who attended the 105 Squadron OTU on Spitfires. Except for an attempt (which failed) to introduce the Fokker S.11 as a primary trainer, the FS did not undergo any significant syllabus changes until March 1956 when it was reorganised at Tel-Nof.

Retirement of the Spitfire

In late 1955 it was realised that the days of the Spitfire were numbered, and it was decided to convert 105 Squadron to the Mustang. However, only the graduates of the 20th FC in June 1956 attended the Mustang OTU with 105 Squadron. The days of piston-engined fighters were over, and in the jet age there was no point in providing a Mustang OTU for a future jet fighter pilot. The

February 116 Sqn with P-51s formed at Tel-Nof with Major Itshak Yavneh as CO. Major Yavneh was the CO of the FS and the new unit was staffed by the FS QFIs as an emergency unit.

April The only two IDF/AF Sikorsky S-55 helicopters arrived in Israel by ship from the US. However, conversion of two pilots in the US did not begin until July 1956.

1 April 101 Sqn reformed with Mystères at Hatzor with Captain Binyamin Peled as CO. Twelve Mystères were delivered to Israel in April, a dozen in May, 36 in August and one in September 1956.

12 April Lieutenant David Kishon in a 113 Sqn Ouragan shot down an intruding EAF Vampire.

28 May 109 Sqn disbanded. Its Mosquitos were stored at Sirkin in operational status for possible use in an emergency by 110 Sqn which became a reserve squadron.

28 June The FS 20th Flying Course graduation. Ten graduates. This was the first, and last, flying course whose graduates were to receive a P-51 OTU with 105 Sqn, which withdrew its last Spitfires in May 1956.

3 September 119 Sqn with Meteor NF.Mk 13s was formed at Ramat-David with Captain Yoash Tsiddon as CO. Two Meteor NF.Mk 13s arrived in Israel in September and a third in October.

October Deliveries of the last IDF/AF Mosquitos commenced. Two Mosquito PR.Mk 16s arrived in Israel, followed by a third in December.

28 October Captain Yoash Tsiddon and Lieutenant Elyashiv Brosh, in a 119 Sqn Meteor NF.Mk 13, shot down an EAF Il-14 on a VIP mission from Damascus to Cairo.

29 October Israel launched Operation Kadeshas, its part in the Anglo-French attempt to retake the Suez Canal Zone from Egypt.

10 November 103 Sqn's Helicopter Flight formed at Tel-Nof with Captain Uri Yarom as CO. The flight inherited the surviving Hiller 360 from 100 Sqn, to which the two Sikorsky S-55s were added.

1 December The FS 21st Flying Course graduation. Twelve graduates.

16 December 109 Sqn reformed with Mystères at Ramat-David with Major Menahem Bar as CO. It was the third IDF/AF fighter unit he had formed.

1957

115 Sqn disbanded at Tel-Nof.

Above: Harvards had an emergency war role of ground attack, and many wore camouflage accordingly. The type saw some action in this role with 140 Sqn during the Sinai Campaign.

Below: Sizeable numbers of Harvards were in service as basic trainers and for general purposes. The trainer aircraft were mostly in an all-over yellow scheme.

A dozen Harvards overfly the ceremony for the graduation of the 5th Flying Course on 27 December 1951. Lined up are more Harvards, an Anson, a Consul and Stearmans.

This Egyptian Sokol (serial number 322) was captured intact at El-Arish during the Sinai adventure. Major Yeshayahu 'Shaya' Gazit (standing in front with an Uzi machine-gun) flew the aircraft back to Tel-Nof.

obvious step was to provide a Meteor OTU, but Major Itshak Yavneh, the newly appointed FS CO who had received his wings on 10 May 1949, was one step ahead. Since the FS was basically a fighter pilots' school it would not be economic to produce a future pilot who might not be found fit to fly jet fighters. Yavneh suggested that instead of giving the air cadet his wings after the basic training phase on Harvards, the wings should be given following an advanced training stage on jet fighters. Only then would the FS's *raison d'être* – to produce jet fighter pilots – be fulfilled. Yavneh's opinion was accepted and in 1957 117 Squadron became the FS advanced training squadron, although it remained at Ramat-David due to operational considerations. The FS graduates then attended a 113 Squadron OTU on Ouragans. The first such course began in November 1956 and lasted until February 1957, with the 20th FC graduates as the trainees, plus several of their former 105 Squadron OTU instructors who had to adjust themselves to the jet age.

In 1957 the French Fouga Magister was selected as the future FS trainer for what was expected to be an all-jet syllabus, but it did not enter service until 1960. In December 1957 Lieutenant Colonel Gazit succeeded Lieutenant Colonel Yavneh as the FS CO. The following year a formal aerobatic team was formed with Harvards by Major Israel Ben-Shachar, the FS chief instructor.

By the end of the decade the FS syllabus was settled on a primary training stage on Stearmans with 140 Squadron, a basic training stage on Harvards with 147 Squadron, and an

May Due to severe shortage of flying hours the IDF/AF despatched to France six 101 Sqn pilots, seven 109 Sqn pilots, and two pilots and four navigators from 119 Sqn, to fly a tour of duty with regular French squadrons at Cambrai (EC 12, Mystères), Dijon (EC 2, Mystères) and Tours (ECTT 30, Meteor NF.Mk 11s). Of the 119 Sqn team, one pilot and two navigators remained at Tours to commence conversion to the Vautour IIN.

25 July The first IDF/AF Alouette II, a donation from Madame Deutsch de la Meurthe, arrived in Israel inside a Noratlas.

1 August First IDF/AF Vautour IIA arrived in Israel. Deliveries of 17 Vautour IIAs, seven Vautour IINs and four Vautour IIBs were completed by April 1959.

November The first Fouga Magister arrived in Israel. Selected as the future IDF/AF trainer in 1956, local production was to be undertaken by Bedek Aviation, the forerunner of IAI, but deliveries to the IDF/AF only commenced in 1960.

1958

1 January 124 Sqn formed at Tel-Nof as the first IDF/AF helicopter unit, with Major Uri Yarom as CO. The unit succeeded 103 Sqn Helicopter Flight which operated two S-55s, a single Hiller 360 and a single Alouette II.

19 January 110 Sqn reformed as a Vautour unit at Ramat-David with Major Yehezkel Somech as CO. The unit only started flying the Vautours in April 1958.

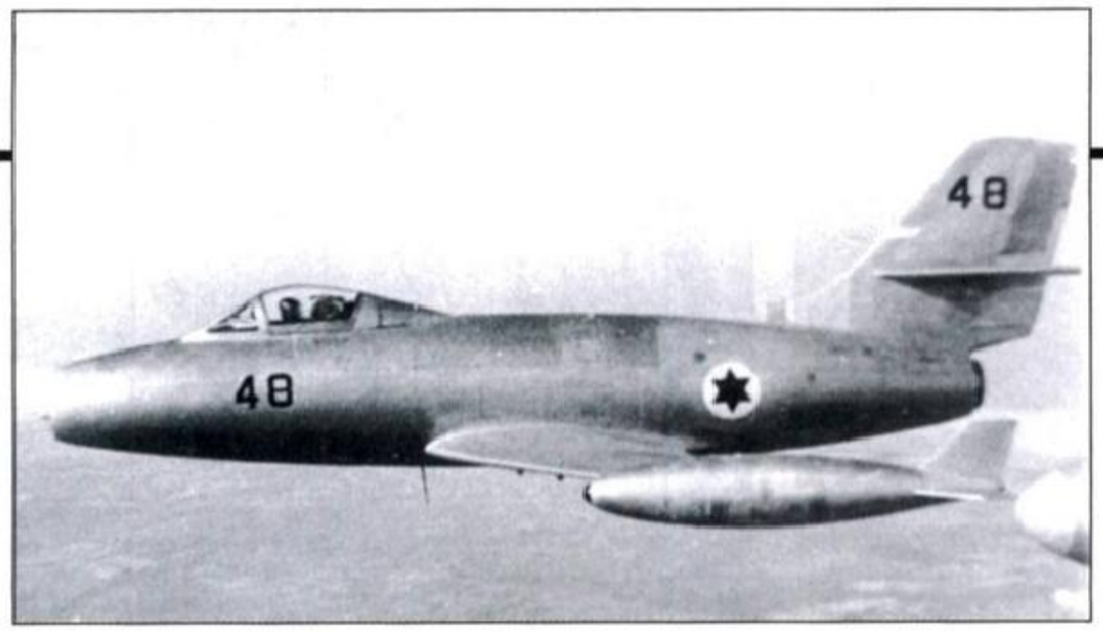
10 February First three Sikorsky S-58s arrived in Israel by ship from the US.

20 February The FS 24th Flying Course graduation.

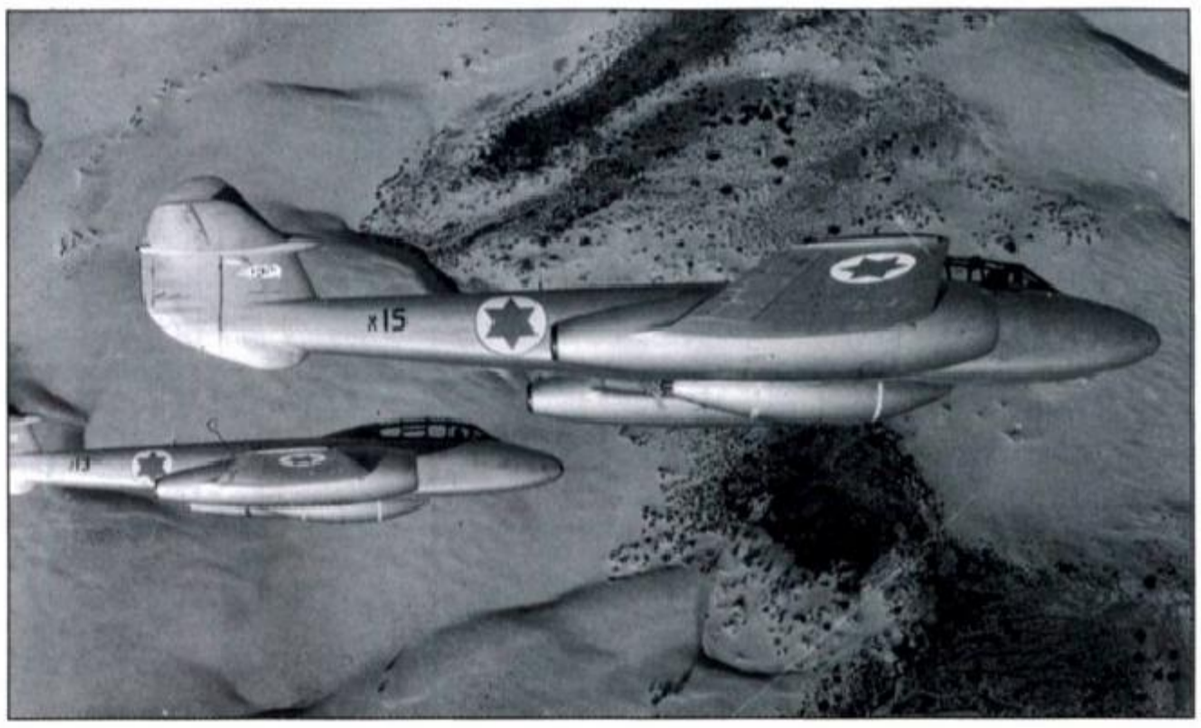
March Three Meteor NF.Mk 13s, embargoed since 1956, were ferried to Israel although one was written off en route in a crash landing at Chateaudun, France.

26 June The FS 25th Flying Course graduation.

25 July Major General Ezer Weizman



Ouragans were largely relegated to training duties after the arrival of the Mystères, serving with 113 Squadron at Hatzor. This plain aircraft is seen during the first 113 Sqn OTU course in February 1957.



Right: Meteor T.Mk 7s were used for advanced training, serving with 117 Sqn at Ramat-David. From 1956 Meteor T.Mk 7s were also used for photo-reconnaissance, converted for the task and flown by 115 Sqn from Tel-Nof.

advanced training stage on Meteors with 117 Squadron. The Ansons and Consuls were withdrawn from use, and several Harvards were converted as three-seaters for navigator training with a pilot, a navigation instructor and a trainee navigator.

Operations

The outcome of the Israeli War of Independence was not a peace treaty with its neighbouring Arab nations but a series of four fragile ceasefire agreements with Lebanon, Syria, Jordan and Egypt. The Iraqi forces withdrew back home without even that little, and as a consequence Israel and Iraq have been in a constant state of war since 1948.

Until 1956 Israel's new borders were not peaceful. Armed clashes resulted in many victims to both sides, but usually the IDF/AF did not participate, especially not across the border. Although it was clear that the use of the IDF/AF might save lives, its deployment would be viewed as an escalation. Israel, with its enormous economic and demographic problems, was in a dilemma: it was essential to reduce the international impact of the border clashes, yet it was also essential to strike back as hard as possible in order to obtain some measure of deterrence against the Arab aggressors. The IDF/AF's contribution was restricted to border patrols and casualty evacuation by the Piper Cubs of 100 Squadron, plus the occasional 'attack' by the Spitfires and Mustangs of 101 Squadron and 105 Squadron on the camel convoys of Bedouin smugglers or cross-border thieves.

The initial use of the IDF/AF for a retaliatory operation occurred in April 1951 after a Syrian ambush resulted in seven dead Israelis. On 5 April four 101 Squadron Mustangs attacked with rockets, and four 105 Squadron Spitfires dive-bombed, Syrian strongpoints in the area of the ambush, but the diplomatic repercussions of that action did not encourage the use of the IDF/AF in those border clashes except for emergency cases.

Seen in the winter of 1957/58, this Harvard turns into the pattern at its home base, Tel-Nof. Camouflaged Harvards usually wore yellow bands when engaged in training duties.

Spitfires were used in the operational training role for many years, suffering many accidents along the way. Here a 105 Sqn aircraft has collided with a squadron-mate.

Fighting on the border

The first such case occurred the next month, when Syrian and Israeli forces clashed in the Tel-Motila area. Although the engagement was well within the Israeli side of the border, the IDF/AF was not called to support the hard-pressed IDF ground forces until 6 May, when the situation was so grave that the local air support officer, on his own initiative, called for the support of a quartet of 105 Squadron Spitfires on a routine training flight. Luckily, the Spitfires' 20-mm cannon were armed. Even luckier was the fact that the leader of the formation was Lieutenant Colonel Augarten, Ramat-David air base CO and a veteran of World War II and the Israeli Independence War, who was leading not three OTU trainee pilots but three fighter pilots who were supposed to be tested by Lieutenant Colonel Augarten as formation leaders.

Lieutenant Colonel Augarten did not respond immediately to the ground forces' plea but first sought the approval of IDF/AF AHQ. This was granted, but the leader was ordered not to use his weapons! The Spitfires came in and made numerous dummy strafing passes on the Syrian forces, although one of the Spitfire pilots ignored the leader's order and did fire his cannon. The immediate result was a Syrian withdrawal; the battle was won, and although all four Spitfires were damaged by the dense Syrian AA fire the incident was considered a success. Colonel Itshak Rabin, then the IDF GHQ Head of Operations Department (and later Israel's Prime Minister until his assassination in November 1995), studied the incident and summarised, "it was the day of the air force." Contrary to what might have been expected from that success, the IDF/AF continued in the next five years to support IDF

succeeded Major General Dan Tolkowsky as IDF/AF CO.

August 105 Sqn reformed as a Super Mystère B.2 unit at Hatzor with Major Ya'acov 'Yak' Nevo as CO. The delivery of 24 Super Mystères commenced in December 1958.

25 August The FS 26th Flying Course graduation.

4 December First four SMBDs arrived in Israel; deliveries of 24 were completed by 1959.

20 December Major 'Yak' Nevo shot down an EAF MiG-17 over Egyptian territory in a well-planned ambush. Although at the time Major Nevo was 105 Sqn CO, this unit had yet to achieve its IOC and in that air-to-air engagement Major Nevo flew a 101 Sqn Mystère.

1959

The FS 29th Flying Course graduation. Among the graduates was Avihu Ben-Nun, IDF/AF CO 1987-1992.

April Rafael commenced development of the Shafrir AAM.

April IDF/AF air staff transferred to Tel-Aviv from Ramle.

May IDF/AF training delegation commanded by Lieutenant Colonel Adam Shatkai arrived in Ghana to train the local air force.

June The FS 30th Flying Course graduation with a single graduate. This was a turning point in the history of the IDF/AF flying courses, for the production of just one pilot resulted in a major revision. Although some claimed that in a normal situation even the lone graduate would not have received his wings, the graduate, Yoseph Aviv, eventually became a Mystère Sqn CO and an A-4 Skyhawk Sqn CO.

23 June Major Daniel Shapira, the IDF/AF chief test pilot, became the first IDF/AF pilot to fly the Mirage, which was the IDF/AF fighter of the 1960s.

IDF/AF order of battle at 31 December 1959

BASE	UNIT	TYPE
Ramat-David	109 Sqn	Mystères
	110 Sqn	15 Vautour IIAs and 4 Vautour IIBRs
	117 Sqn	Meteors (FS advanced training squadron)
Sde Dov	100 Sqn	Piper Super Cubs
Tel-Nof	103 Sqn	C-47s, Noratlases
	116 Sqn	Mustangs (emergency unit)
	119 Sqn	7 Vautour IINs and 5 Meteor NF.Mk 13s
	124 Sqn	S-58s, 2 S-55s and 1 Alouette II
Hatzor	101 Sqn	Mystères
	105 Sqn	SMBDs
	113 Sqn	Ouragans (the IDF/AF OTU)

operations but was not allowed to execute any offensive actions of its own.

In April 1954 an Israeli navy boat ditched on the Saudi Arabian coastline and the IDF/AF played the major role in the retrieval of its crew from hostile territory. The C-47s of 103 Squadron flew communication relay missions, 109 Squadron Mosquitos photographed the scene, and seven 100 Squadron Piper Cubs evacuated the seven Israeli seamen under the cover of 109 Squadron Mosquitos and 101 Squadron Mustangs. The latter also ended the incident when they attacked and destroyed the abandoned Israeli boat.

A year later, a similar story was enacted. In June 1955 the IDF despatched a team of six men to survey the route from Eilat to Sharm El-Sheikh. Egypt had blocked the Strait of Tiran to Israeli shipping and Israel was considering the military option in order to protect its rights. Once again the 103 Squadron C-47s were used for communication relay, but they also dropped water and supplies to the surveyors. When it was clear that an Egyptian unit was following the Israelis the 100 Squadron Piper Cubs repeated the previous year's action and retrieved the six surveyors. Three of the Piper Cub pilots participated in both operations, obtaining the unique achievement of landing both in Saudi Arabia and Egypt within slightly more than a year.

Egyptian skirmishes

In August 1955 the situation on the Egyptian border deteriorated and 117 Squadron deployed a detachment of Meteors for quick reaction alert (QRA) at Hatzor. Several inconclusive engagements against the EAF Vampires from El-Arish were followed by the 1 September air combat in which Captain Aharon Yoeli and Captain Yoash Tsiddon intercepted four EAF Vampires, and Captain Yoeli shot down two. Both crashed on Israeli soil, supplying the ultimate proof for the often unfounded fighter pilots' claims of a kill. A third EAF Vampire was shot down by Lieutenant David Kishon in an Ouragan on 12 April 1956 and it, too, crashed on Israeli soil.

The situation in the Middle East was deteriorating to the point of war, but the IDF/AF was still not at the forefront of the action. Only

Above: Captain Uri Yarom, in an S-55, prepares to lift off a Super Cub from the Mitle Pass after it had been set on fire by MiG-15s. The Cub was airlifted back to Ramle via El-Arish.

Below: The same S-55 is seen during Operation Steiner, just after the end of the Sinai Campaign. It was assigned to 103 Sqn's 124 Flight.

when the IDF ground forces were involved in a difficult situation, as occurred on the night of 10/11 October 1956, was the IDF/AF called for support. In that particular incident two Harvards and two Mustangs were despatched to assist IDF ground forces which were entangled in combat with Jordanian units during an IDF retaliation operation against the Kalkilya police station. The nocturnal capability of the IDF/AF in those days was very limited, and although the IDF ground forces managed to handle the situation they suffered 18 killed and 68 wounded from Jordanian fire.

Sinai Campaign

The scene was set for the Sinai Campaign of October and November 1956. The IDF, working in concert with Anglo-French forces, launched its part of the offensive on 29 October when the 890th Regiment was parachuted by the C-47s of 103 Squadron near the Mitle Pass in Sinai. During the next two days Israel and Egypt clashed in Sinai, and on the evening of 31 October the Anglo-French forces launched their offensive in Suez. Fighting in Sinai continued until 5 November, when almost the whole of Sinai was in Israeli hands and the Straits of Tiran were at last open to Israeli shipping. The IDF/AF flew 1,846 operational sorties and more than met the IDF's expectations. The Mystères flew both air-to-air and air-to-ground missions and claimed seven kills: Captain Ya'acov 'Yak' Nevo claimed a MiG-15 and a MiG-17; Lieutenants Shai Agozi and Aharon 'Yalo' Shavit claimed two Vampires each; and Lieutenant Yoseph Tsuk claimed a MiG-15. A single Mystère was lost to AA fire on an air-to-ground mission but its pilot, Major Binyamin Peled, became the first IDF/AF pilot to use an ejection seat. The Ouragans and Meteors mainly flew air-to-ground missions and both proved to be extremely robust aircraft; not one was lost, and a degree of air-to-air success was achieved. Captain Ya'acov Agasi of 113 Squadron was credited with a probable MiG-15 kill, while the only 119 Squadron Meteor NF.Mk 13 crew, Captain

Although wearing the colours of El-Al, this Noratlas was used as a military transport during the Sinai Campaign, for which the black/yellow identification stripes were added.

Rocket-equipped Mustangs were heavily used in Sinai, proving to be effective yet vulnerable in the ground attack role.

Tsiddon and Lieutenant Brosh, shot down an EAF Il-14 on the evening of 28 October.

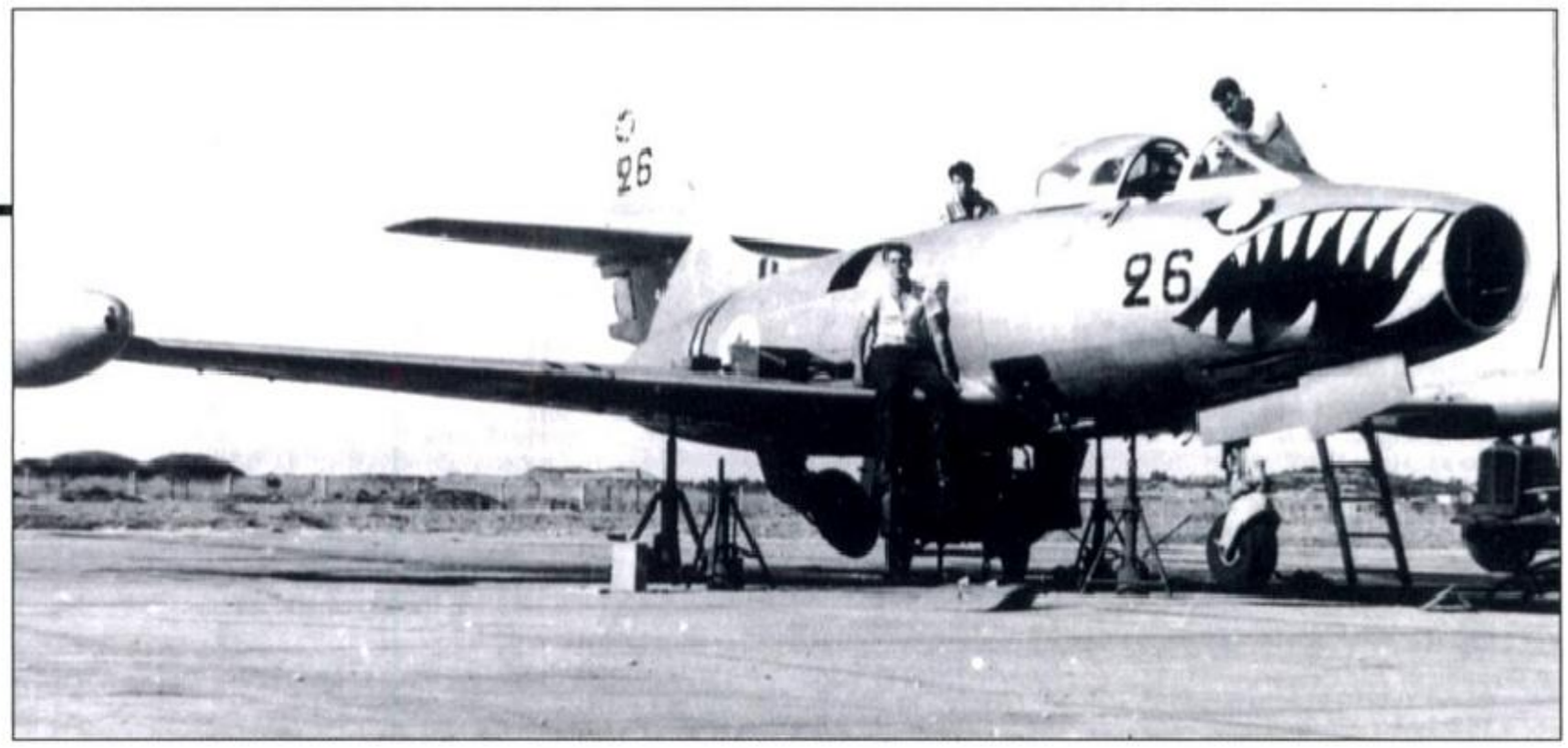
Finale for the Fortress and Mustang

As for the piston-engined aircraft, the Sinai Campaign was their swansong. The B-17s, Harvards and Mosquitos were briefly used, and two Harvards were lost to AA fire. The Mustangs were widely used in the air-to-ground role but their liquid-cooled engine proved to be extremely vulnerable to AA fire, and since the Mustangs flew at low level they were exposed to a lot of AA fire. Nine Mustangs were lost: 105 Squadron suffered three losses and 116 Squadron lost six aircraft. Two Mustang pilots were killed – one from each unit – another became a prisoner of war and the other six were retrieved. Among those six was Captain Eldad Paz, who walked more than 60 km (37 miles) in the desert, for 37 hours, to return home.

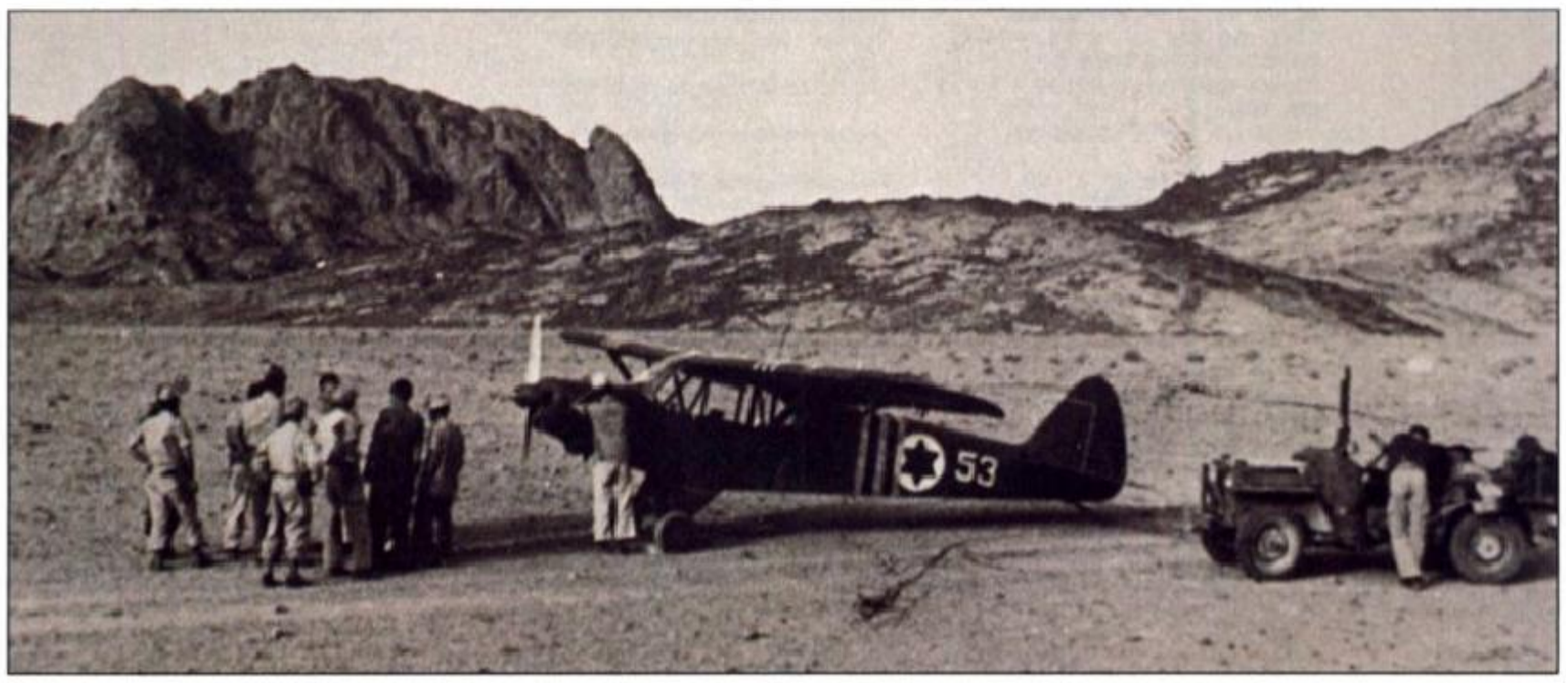
Of the other IDF/AF units, 100 Squadron was the only unit to suffer any casualties when it lost two of its Piper Cubs, both to EAF MiG-15s. Captain Binyamin Cahana's aircraft was shot down by two MiG-15s after a 15-minute air combat, while Sergeant Moshe Bokai's aircraft was destroyed on the ground at the Mitle Pass by strafing EAF MiG-15s. Both pilots were decorated: the first for sacrificing his life to save the IDF unit which the EAF MiG-15s intended to attack; the second for risking his life to extricate from his burning aircraft a wounded paratrooper whom Sergeant Bokai was supposed to evacuate when the MiGs arrived. Another lightplane loss was sustained on the night of 6/7 November when Sergeant Binyamin Gordon, an Israeli police pilot on reserve duty with 100 Squadron, was flying the IDF Southern Command CO Major General Asaf Shimhoni back home from Sharm El-Sheikh in a Police Piper Pacer. The aircraft drifted east during the long flight and crashed near Nablus in Jordanian territory. All three occupants were killed.

By the end of the Sinai Campaign the IDF CoS General Moshe Dayan stated that from then on, the IDF's order of priorities would be "air

Above: A UN observer stands by the wreckage of an Egyptian Vampire, one of two shot down by Captain Yoeli in a Meteor FR.Mk 9 on 1 September 1955.



Above: Photographed in November 1956 just after Sinai, this Ouragan is receiving maintenance at Hatzor. Ouragans were used widely on attack duties in the short conflict.



Above: Captain Binyamin Cahana's Super Cub was shot down by Egyptian MiG-15s on 30 October 1956. This was the only aerial victory achieved by the EAF.

Left: 100 Sqn's Super Cubs were heavily used in the Sinai, their land-anywhere capability proving to be of inestimable value in the liaison role.

Above: Nine Mustangs were shot down by ground-fire in the hectic fighting in Sinai, most being lost with engine damage.

Below: This EAF MiG-15 was shot down by Captain Ya'acov 'Yak' Nevo in the Sinai fighting, and was retrieved by Israeli forces. It was originally planned to restore the aircraft to flying condition for evaluation purposes, but the damage was too extensive. It ended up in this display at Hatzor.

A Mystère IVA from the French air force's EC 1/2 taxis at Ramat-David during the Sinai conflict. This French unit operated under the shadow designation of 199 Squadron, IDF/AF.

In late 1956, French Noratlas transports flew from Tel-Nof, operating as '203 Sqn'. Other French squadrons were '199' and '201' (Mystères at Ramat-David) and '200' (F-84Fs at Lod).

force, paratroopers, armoured corps." The IDF/AF had proved its worth.

UN pressure and MiG-baiting

The next three years until the decade ended were much less eventful. Israel, unlike its Anglo-French allies, did achieve its diplomatic goals after the Sinai Campaign, although following joint US and USSR pressure it had to evacuate Sinai in March 1957. However, the Egyptian army was not allowed to return to its former base and United Nations' forces filled the vacuum. The IDF/AF continued with its low-profile operational activity of reconnaissance missions, nocturnal intrusions of enemy airspace, casualty evacuation, transport, border and maritime patrol, search and rescue, etc.

Two interesting incidents brought the decade to an end. In those days the Egyptian air force rotated its fighter squadrons to El-Arish air base, and many times when a new EAF fighter unit arrived at El-Arish the IDF/AF fighter pilots would 'test' it. On 20 December 1958 a team of four IDF/AF fighter pilots made an unauthorised ambush on the El-Arish flyers. The plan was simple. A pair would fly along the border and provoke the EAF aircraft to a chase, at which point the other pair would come in behind the EAF MiG-17s. The four pilots flew 101 Squadron Mystères but only two of them belonged to that unit. Lieutenant Colonel Mordechai Hod was leading the bait pair, with Major Aharon Yoeli as his wingman. Hod was the Hatzor air base CO and a future IDF/AF CO (between 1966 and 1973). Yoeli was 101 Squadron CO. The hunting pair was led by Major Ya'acov 'Yak' Nevo with Captain Amos Lapidot as his wingman. Nevo was the CO of 105 Squadron, a unit which was just forming but had yet to achieve its IOC on the SMBDs, and Lapidot, too, would be a future IDF/AF CO (between 1982 and 1987). The Egyptians fell into the trap, but unfortunately the MiG-17 that Major Nevo shot down crashed onto Egyptian soil and caused a diplomatic incident.

A similar incident ended with a different result on 4 November 1959. This time four 105 Squadron SMBDs engaged the MiG-17s. The leader was the unit's CO Major Nevo, but the engagement had to be aborted when his No. 3, Captain David Ivry, entered a spin, lost control of his aircraft and had to eject. Ivry, who became the IDF/AF CO from 1977-82, was recovered by a 124 Squadron S-58 flown by the unit's CO Major Uri Yarom. With so many COs involved, you can be sure that the incident was not a coincidence! **Shlomo Aloni**

INDEX

Page numbers in **bold** refer to an illustration

75 (see Boeing [Stearman])
360 (see Hiller)
696 Shackleton (see Avro)
747 (see Boeing)
2501 Noratlas (see Nord)

A

A-4 (A4D) Skyhawk (see Douglas)
A-25 Helldiver (see Curtiss)
A-37 Dragonfly (see Cessna)
A Decade of Air Power: Israel 1950-1959: 142-157, **142-157**
Aérospatiale/BAe Concorde: 140
Airspeed Consul: 144, 148, 151, **152-154**, 155
Akron, USS (ZRS-4): 26, 29
Albatross, SA-16 (see Grumman)
Albatross, UF-1G (see Grumman)
Alouette II (see Sud-Aviation)
An-2 *et seq* (see Antonov)
Anson (see Avro)
Antonov An-12 'Cub': 138
Ar 65 *et seq* (see Arado)
Arado
Ar 66: 19, 23
Ar 66C: **13**, 14
Argentina
Navy (Commando Aviación Naval Argentina): 117, 118
Ark Royal, HMS: 115
Ashland, LST: **119**, 120
AT-21 Gunner (see Fairchild)
Attacker (see Supermarine)
Australia
Royal Australian Air Force: 58, 88, 117, 123
Austria
Air Force: 82
Avia S-199: 144, 148
Avro
696 Shackleton: 73
Anson: 144, 148, 151-153, **151**, **154**, 155
Lancaster: 145, 146
Vulcan K.Mk 2: 82, **83**

B

B-1 (see Rockwell)
B-2A Spirit (see Northrop)
B-17 Flying Fortress (see Boeing)
B-24 Liberator (see Consolidated)
B-29 Superfortress (see Boeing)
B-35 (see Northrop)
B-36 (see Convair)
B-47 Stratojet (see Boeing)
B-50 (see Boeing)
B-52 Stratofortress (see Boeing)
B-314 (see Boeing)
BAC
Strikemaster: 56, 59
TSR.2: 41, 47, 63, 88
'Backfire' (see Tupolev Tu-22M)
'Badger' (see Tupolev Tu-16)
BAe
EAP: 89, 100
Harrier: 62, 66, **66**, 72, 81, 83, 88
Banshee, F2H (see McDonnell)
'Bear' (see Tupolev Tu-95)
'Bear-D' (see Tupolev Tu-95RT)
Beaufighter (see Bristol)
Beech Bonanza: 144, 149
Bell X-1: 39
Bf 109 (see Messerschmitt)
Bf 109a *et seq* (see Messerschmitt)
Bf 110 (see Messerschmitt)
Bf 110C *et seq* (see Messerschmitt)
'Bison' (see Myasishchev M-4/3M)
Blackburn/Hawker Siddeley Buccaneer: 66, 85, 88, 89, 91
'Blackjack' (see Tupolev Tu-160)
'Blinder' (see Tupolev Tu-22)
Boeing
747: 140
B-17 Flying Fortress: 27, 46, 144, 146-148, **147**, **149**, 151, 152, 156
B-29 Superfortress: 27, 29, 30, 102-106, **102**, **103**, **105**, **106**, **108-113**, 109-111, 113, 126, 129
B-47 Stratojet: 113, **113**
B-50: 113
B-52 Stratofortress: 113
B-314: 124
C-97 Stratofreighter: 30
EB-29B: 28, 29, **30**, 31-34, **31**, **32**, **34**
KB-29: 113
KC-97: 113
KC-135 Stratotanker: 53, 54, 94, 113
PBB Sea Ranger: 126, 129
XPBB-1 Sea Ranger: 126, 129
Boeing (Stearman) 75: 144, 148, 151, **152-154**, 154
Bonanza (see Beech)
Brigand (see Bristol)
Bristol
Beaufighter: 144
Brigand: 146
BT-13 (see Vultee)
Buccaneer (see Blackburn/Hawker Siddeley)

C

C-46 Commando (see Curtiss)
C-47 Skytrain/Dakota (see Douglas)
C-54 Skymaster (see Douglas)
C-82 Packet (see Fairchild)
C-97 Stratofreighter (see Boeing)
C-130 Hercules (see Lockheed Martin)
'Camel' (see Tupolev Tu-104B)
Canadair Sabre: 145
Canadian Car & Foundry Norseman: 144
Canberra (see English Electric)
Catalina, PBY (see Consolidated)
Cessna A-37 Dragonfly: 132
Chipmunk, DHC-1 (see de Havilland Canada)
Commando, C-46 (see Curtiss)
Concorde (see Aérospatiale/BAe)
Consolidated
B-24 Liberator: 126
P6Y-1: 133
PB2Y Coronado: 116
PB4Y: 126
PBY Catalina: 114-117, 124, 125, **126**, 128, 148, **149**, 152
PBY-4: 114
XP5Y-1: 133
Consul (see Airspeed)
Convair
B-36: 26-29, **26**, 35
F-102 Delta Dagger: 45-47
F-106 Delta Dart: 47
'Coot-A' (see Ilyushin Il-18)
Coronado, PB2Y (see Consolidated)
C.R.42 (see Fiat)
'Cub' (see Antonov An-12)
Cub, L-4 (see Piper)
Currituck, USS: 119
Curtiss
A-25 Helldiver: 27
C-46 Commando: 27, 144, **149**, 150
F9C-2 Sparrowhawk: 26, 27, 29
SOC Seagull: **125**
XP-71: 27
CV-E (see Fokker)

D

Dakota (see Douglas C-47 Skytrain)
Dassault
Mirage: 151, 152, 155
Mirage III: 55, 56, 81, 143, 145
Mirage F1: 59, 67, 101
Mystère: 143, **143**, 145, **145**, 149, 151-157
Mystère IVA: 143, **143**, 145, **157**
Ouragan: 143-145, **143**, **145**, 150-154, **155**, 156, **157**
Super Mystère: 142, **143**, 145, **146**, 152, 155-157
de Havilland
D.H.89 Dragon Rapide/Dominie: 144, 149
D.H.98 Mosquito: 144, 146-150, 153, 156
D.H.100 Vampire: 38, 152, 153, 156, **157**
D.H.110 Sea Vixen: 46, 96
D.H.112 Sea Venom: 61
Mosquito FB.Mk 6: 147, **147**, 148, 151
Mosquito NF.Mk 30: 146, **146**, 147
Mosquito PR.Mk 16: 144, 147-149, **148**, 151, 153
Mosquito T.Mk 3: 147, **147**
Mosquito TR.Mk 33: **148**, 151
Sea Vixen FAW.Mk 2: 50
Venom: 91
de Havilland Canada DHC-1 Chipmunk: 99, 148, 151, **153**
Delta Dagger, F-102 (see Convair)
Delta Dart, F-106 (see Convair)
Demon, F3H (see McDonnell)
Denmark
Air Force (Kongelige Danske Flyvevaaben): 13
D.H.82 *et seq* (see de Havilland)
DHC-1 Chipmunk (see de Havilland Canada)
Do 17 *et seq* (see Dornier)
Dolphin (see Sopwith)
Dornier Do 17: 14
Douglas
A-4 (A4D) Skyhawk: 155
C-47 Skytrain/Dakota: 45, **126**, 144, 148-152, **149**, **151**, 156
C-54 Skymaster: 105, 144
Dragon Rapide, Dominie, D.H.89 (see de Havilland)
Dragonfly, A-37 (see Cessna)
Draken, J 35 (see Saab)

E

Eagle, F-15 (see McDonnell Douglas)
EAP (see BAe)
Eastern Front Schlachtflieger: 4-25, **4-25**
EB-29B (see Boeing)
EFA (see Eurofighter)
Egypt
Air Force: 57, 145, 146, 152, 153, 155-157
Army: 157
English Electric
Canberra: 39, 40, 43, 45, 47, **53**, 65, 67, 91, 95
Lightning: 36-101
Lightning F.Mk 1: 42-45, **42-45**, 47, 48, 50-53, **51**, 55, 60, 62, 63, 65, **65**, 67, 75, **87**, 90, 92, **92**, 93, 95-100, **95**, **98**
Lightning F.Mk 1A: 42, 45-48, **45-47**, 50-52, **54**, 60, 62-65, **64**, 67, **67**, **69**, **71**, **74**, **87**, 92, 93, **93**, 95-98, **95**, **97**
Lightning F.Mk 2: 42, 47-54, **47-51**, **53**, **55**, 56, 57, 59-64, 72-75, 88, 92-94, **92**, **94**, **96**, 96, 97, 100, 101
Lightning F.Mk 2A: 49, 50, 55, 60-62, **61**, **62**, 64, 66, **66**, 72, 74, **86**, **87**, 92, 94, **94**, 96, **96**, 97, 100
Lightning F.Mk 3: **36-37**, 42, 43, 46, 48, 49, 51-56, **51**, **53-56**, 57-67, **65**, **69**, 71-74, **71-74**, **80**, 81-83, **83**, **84**, 87, **87**, 89, **89**, 92-101, **92-97**, **99**, **100**
Lightning F.Mk 3A: 53-55, **55**, 57, 60, 92
Lightning F.Mk 6: **38**, 40, 41, 49, 53-65, **56**, **60**, **65**, 67, 71-73, 75-79, **75-79**, 81-83, **81**, **82**, 85, **85-91**, 89-100, **89-91**, **93-96**, **99**
Lightning F.Mk 52: 57, **58**, 62, 82, **91**, 92, 100, 101
Lightning T.Mk 4: 42, **43**, 48, **48**, **50**, 52, **52**, 56, 57, 62-64, **64**, **66**, **70**, 74, 84, 92, 94, 97, 99, **99**, 100, 101
Lightning T.Mk 5: 55-59, 62-65, **63**, **64**, 67, 74, **77**, 78, **79**, 81-84, **83-85**, 88-93, **94**, **96**, **97**, 97-99, **99**, 101
Lightning T.Mk 54: 57, **58**, 82, **91**, 92, 100, 101
P.1A: 39-42, **40**, 51, 55, 72, 77, 78, 87, 90, **90**, 92
P.1B: 39-43, **41**, 45, 48, 51, 53, 55, 90-92, 99
P.8: 87, 88
P.11: 48, 52
P.15 *et seq*: 88
English Electric (BAC)
Lightning F.Mk 53: 54, 56-59, **56-58**, 73, 75, 82, **86**, 88, 89, 91, 92, 100, **100**, 101, **101**
Lightning F.Mk 53K: **56**, 58, 101, **101**
Lightning T.Mk 55: 56-58, **57**, **58**, 63, **70**, 82, 88, **89**, 91-93, 97, 100, **100**, 101
Lightning T.Mk 55K: **56**, 58, **59**, 101, **101**
English Electric Lightning: 36-101, **36-101**
Eurofighter EFA: 54, 86, 87

F

F1, Mirage (see Dassault)
F2H Banshee (see McDonnell)
F3H Demon (see McDonnell)
F-4 Phantom II (see McDonnell Douglas)
F4F Wildcat (see Grumman)
F4H Phantom II (see McDonnell)
F-5A/B/C/D Freedom Fighter (see Northrop)
F6F Hellcat (see Grumman)
F9C-2 Sparrowhawk (see Curtiss)
F13 (see Junkers)
F-15 Eagle (see McDonnell Douglas)
F-16 Fighting Falcon (see Lockheed Martin)
F-51 Mustang (see North American P-51)
F-80 (see Lockheed Martin P-80 Shooting Star)
F-84F Thunderstreak (see Republic)
F-86 Sabre (see North American)
F-88 (P-88) (see McDonnell)
F-100 Super Sabre (see North American)
F-101 Voodoo (see McDonnell)
F-102 Delta Dagger (see Convair)
F-104 Starfighter (see Lockheed Martin)
F-104A *et seq* (see Lockheed Martin)
F-106 Delta Dart (see Convair)
F-111 (see Lockheed Martin)
F/A-18 Hornet (see McDonnell Douglas)
Fairchild
AT-21 Gunner: 27
C-82 Packet: 28, 30, 34
'Fat Man' atomic weapon: 103, 105, 107, 111, 112
FB-111 (see Lockheed Martin)
'Fencer' (see Sukhoi Su-24)
FH Phantom (see McDonnell)
Fi 156 Storch (see Fieseler)
Fiat C.R.42: 13, **13**
Fieseler Fi 156 Storch: 5, 8
Fighting Falcon, F-16 (see Lockheed Martin)
'Fishbed' (see Mikoyan MiG-21)
'Fishpot' (see Sukhoi Su-9)
'Fitter-A' (see Sukhoi Su-7 Mk II)
'Flagon' (see Sukhoi Su-15)
'Flanker' (see Sukhoi Su-27)
'Flogger' (see Mikoyan MiG-23)
Flying Fortress, B-17 (see Boeing)
Focke-Wulf
Fw 58: **12**, 13, **13**, 14, 23
Fw 189: 8, 14
Fw 190: 5, 9, 12, 14, 16, **18**, 19-25, **25**
Fw 190A: **5**, 12, **17**, 21, **22**, **24**
Fw 190D 'Dora': **19**
Fw 190F: 5, **16-19**, 19, 21, **21-23**, **25**
Fw 190G: 17, 21
Fokker
CV-E: 13, **13**, 23
S.11 Instructor: 148, 149, 151, **152**, 153
Triplane: 102
Folland Gnat: 89
Fouga Magister: 154
'Foxbat' (see Mikoyan MiG-25)
France
Air Force (Armée de l'Air): 146, 157
Naval Aviation (Aéronavale): 120, 121, 131
Freedom Fighter, F-5A/B/C/D (see Northrop)
'Frogfoot' (see Sukhoi Su-25)
Fw 58 *et seq* (see Focke-Wulf)

G

Gardiner's Bay, USS: 126
Germany
Air Force (Luftwaffe): 4-25, 69
II Fliegercorps: 5
VIII Fliegercorps: 5, 6
Legion Condor: 4
Army: 5, 23
Reichsluftfahrtministerium (RLM): 4
Gloster
Javelin: 41, 43, 53, **53**, 65, 79, 92-94
Meteor: 38, 40, 45, **67**, 80, **143**, 144-146, **145**, **146**, 149-157, **155**
Gnat (see Folland)
Go 145 (see Gotha)
Goblin, XF-85 (see McDonnell)
Gotha Go 145: **12**, 13, **13**, 14, 19, 23
Grasshopper/Cub, L-4 (see Piper)
Grumman
F4F Wildcat: 26
F6F Hellcat: 30, 31
J4F-2: 133
SA-16 Albatross: 131, 132
UF-1G Albatross: 127, 131
Guavina, USS: 119
Gunner, AT-21 (see Fairchild)

H

Halifax (see Handley Page)
Handley Page
Halifax: 145
Victor B(K).Mk 1A: 53, 54, 60, **62**, 79, 81, 83, 94
Victor K.Mk 1: 50
Harrier (see BAe)
Harvard (see North American T-6)
Hawker
Hunter: 39, 41, 43, **43**, 44, 45, **51**, 54, 57, 58, 63-65, 91-96
P.1154: 52, 88
He 45 *et seq* (see Heinkel)
Heinkel
He 45: 4, 5
He 46: 13, **13**, 14, 23
He 50: **12**, 23
He 111: 12, 20, 23
He 177: 11
Hellcat, F6F (see Grumman)
Helldiver, A-25 (see Curtiss)
Henschel
Hs 123: 4-9, **5**, **6**, 12-14, 18, 19, 22
Hs 123A: 4, 7, **7**, **8**
Hs 123B: 7
Hs 123C: 7
Hs 126: 8, 14, 23
Hs 129: **4**, **5**, **8**, 8-12, 14-18, 22-25, **23**, **24**
Hs 129A: 8, 15
Hs 129B: 8, **8**, 11, **11**, 15, **15**, **16**, 24, **25**
Hercules, C-130 (see Lockheed Martin)
Hiller 360: 149, **149**, 151, 153, 154
Hornet, F/A-18 (see McDonnell Douglas)
Hs 123 *et seq* (see Henschel)
Hudson (see Lockheed Martin)
Hunter (see Hawker)

I

Il-2 *et seq* (see Ilyushin)
Ilyushin
Il-2: 22
Il-14: 153, 156
Il-18 'Coot-A': 138
Il-28: 146, 147
Il-38 'May': 80
India
Air Force: 45
Indianapolis, USS: 105
Indonesia
Armed Forces - Air Force (Tentara Nasional Indonesia-Angkatan Udara): 53
Instructor, S.11 (see Fokker)
Iraq
Royal Iraqi Air Force: 153
Israel
Israel Defence Force (IDF): 143, 148, 149, 155, 156
Artillery Corps: 148
Israel Defence Force/Air Force (IDF/AF): 142-157
Air Depot: 142
Air Maintenance Unit: 142
Flying School: 142-145, 148-156
Technical School: 142
Navy: 142, 156
Italy
Air Force (Aeronautica Militare Italiana): 144, 150

J

J4F-2 (see Grumman)
J 21A *et seq* (see Saab)
Jaguar (see SEPECAT)
Javelin (see Gloster)
JRM Mars (see Martin)
JRM-1 *et seq* (see Martin)
Ju 52 *et seq* (see Junkers)
Junkers
F13: **12**, 14
Ju 52: 12, 16
Ju 87 'Stuka': 4-6, 10-12, 14 17, 19-24
Ju 87D: 10, **14**, **17**
Ju 87G-1: **4**, 11, 15-18, **18**, **20**, 23, 24
Ju 88: 11
Ju 88A: 10
Ju 88C: 11, **18**, 23
Ju 88P: 10, **10**, 11
W 34: 14

K

KB-29 (see Boeing)
KC-97 (see Boeing)
KC-135 Stratotanker (see Boeing)
Komet, Me 163 (see Messerschmitt)
Kuwait
Kuwaiti Air Force: 101

L

L-4 Grasshopper/Cub (see Piper)
La-250 (see Lavochkin)
LaGG-3 (see Lavochkin)
Lancaster (see Avro)
Lavochkin
La-250: 136
LaGG-3: 10
Lexington, USS: 30
Liberator, B-24 (see Consolidated)
Lightning (see English Electric)
Lightning, P-38 (see Lockheed Martin)
Lightning F.Mk 1 *et seq* (see English Electric)
Lightning F.Mk 53 (see English Electric [BAC])
Lightning F.Mk 53K (see English Electric [BAC])
Lightning T.Mk 4 *et seq* (see English Electric)
Lightning T.Mk 55 (see English Electric [BAC])
Lightning T.Mk 55K (see English Electric [BAC])
Lightning Operators: 92-101, **92-101**
'Little Boy' atomic weapon: 102, 106, 110, 111
Lockheed Martin
C-130 Hercules: 58, 100
F-16 Fighting Falcon: 52, 67, 86
F-104 Starfighter: 42, 56
F-104G: 42, 62
F-111: 58
FB-111: 113, **113**
Hudson: 144
Model 18 Lodestar: 144
P2V-5: 117
P-38 Lightning: 23
P-80 (F-80) Shooting Star: 29-31, 33
S-3 Viking: 120
U-2: 65
Lodestar, Model 18 (see Lockheed Martin)

INDEX

M

M-4/3M 'Bison' (see Myasishchev)
M.52 (see Miles)
M-130 (see Martin)
M-270 (see Martin)
Macon, USS (ZRS-5): 26, 29
Magister (see Fouga)
Mariner, Model 162 (see Martin)
Mariner, PBM (see Martin)
Marlin, P5M (see Martin)
Mars, JRM (see Martin)
Martin
  JRM Mars: 118, **118**, 129, 133
  JRM-1: 129, **129**
  JRM-2: 129, **129**
  JRM-3: 129
  M-130: 124
  M-270: 126, 130, 131, 133, **133**
  Model 162 Mariner: 114, 122, 123
  Model 162A: 114, 115, 122, **122**
  Model 170: 118
  P3M: 114
  P4M Mercator (Model 219): 129
  P4M-1: 126, 129
  P5M Marlin: 119-121, 128, 133
  P5M-1 (P-5A): 119, **119**, 121, 129-131, **130**
  P5M-1G: 120, 121, 131, **131**, 132
  P5M-1S: 120, 130, 131, **131**
  P5M-1T: 120, 131
  P5M-2 (P-5B): 119-121, **120**, 130, 131, **131**, **132**, 133
  P5M-2G: 120, 121, 131, 132, **132**
  P5M-2S (SP-5B): **119**, 120, 121, **121**, 130, 131
  P5M-2T: 120, 131, 132
  P5M-3: 133, **133**
  P6M Seamaster: 133
  P7M-1 Submaster: 133, **133**
  PBM Mariner: 114, **114**, 116-119, 121-123, 125, 126, **127**, **128**, 133
  PBM-1: **114**, 115, 122, **122**, 123, **123**, 126
  PBM-3: 114-116, 123, **123**, 126
  PBM-3B: 124
  PBM-3C: 115-117, **115**, **117**, 123-126, **124**
  PBM-3D: 116, **116**, 117, 123, 125, **125**, 128
  PBM-3E: 114
  PBM-3R: 114, **115**, 117, **117**, 123, **123**, **124**
  PBM-3S: **114**, **115**, 117, 123-126, **124**, **125**
  PBM-4: 126, 129
  PBM-5: 114, 116, **116**, 117, **117**, 119, 125-127, **126**, **127**, 129, 130
  PBM-5A: 116, 117, **117**, 127
  PBM-5C: 126
  PBM-5D: 118
  PBM-5E: 114, 126, **126**, 127
  PBM-5G: 114, 117, 127, **127**
  PBM-5M: 127
  PBM-5N: 127
  PBM-5S: **117**, 127
  PBM-5S2: 118, 127, **127**, 129
  PM: 114
  XP5M-1: 126, 129, 130, **130**, 133
  XPB2M-1: 118, **118**, 128, **128**, 129
  XPB2M-1R: 118, **118**, 128, **128**
  XPBM-1: 114, 115, 122, **122**
  XPBM-1A: 122
  XPBM-2: 123
  XPBM-3D: 125
  XPBM-3E: 123
  XPBM-5: 126
  XPBM-5A: 127
  XPBM-6: 128
Martin flying-boats: 114-133, **114-133**
'May' (see Ilyushin Il-38)
McDonnell
  F2H Banshee: 27, 30, 31
  F3H Demon: 27
  F4H Phantom II: 27
  F-88 (P-88): 27
  F-101 Voodoo: 27
  FH Phantom: 30
  P-85: 27
  XF-85 Goblin: 26-28, **26-35**, 30-35
  XF-88: 27
  XFD-1: 30
  XP-67: 27
  XP-85: 27-30
McDonnell XF-85: the built-in fighter: 26-35, **26-35**
McDonnell Douglas
  F-4 Phantom II: 44, 59, 62, 64-66, 74, 78, 79, 82, 86, 88, 92, 93, 97
  F-15 Eagle: 52, 57, 58, 78, 82, 86, 101, 142
  F/A-18 Hornet: 86
Me 163 *et seq* (see Messerschmitt)
Mercator, P4M (Model 219) (see Martin)
Messerschmitt
  Bf 109: 5, 6, 8, 9, **10**, 12, 14, 19, 20, 22
  Bf 109E 'Emil': 5, **5**, 6, **6**, 8, 9, **9**
  Bf 109G: **9**
  Bf 110: 5, 6, 10, 16
  Bf 110C: **16**
  Bf 110G: 10
  Me 163 Komet: 32
  Me 262: 18
Meteor (see Gloster)
MiG-15 *et seq* (see Mikoyan)
Mikoyan
  MiG-15: 27, 28, 35, 118, 143, 145, 156, **157**
  MiG-17: 155-157
  MiG-19: 39, 40, 145, 146
  MiG-21 'Fishbed': 45, 87, 152
  MiG-23 'Flogger': 141
  MiG-25 'Foxbat': 134
Miles M.52: 39
Mirage (see Dassault)
Mirage III (see Dassault)
Mirage F1 (see Dassault)
Model 18 Lodestar (see Lockheed Martin)
Model 162 Mariner (see Martin)
Model 162A *et seq* (see Martin)
Mosquito, D.H.98 (see de Havilland)
Mosquito FB.Mk 6 (see de Havilland)
Mosquito NF.Mk 30 (see de Havilland)
Mosquito PR.Mk 16 (see de Havilland)
Mosquito T.Mk 3 (see de Havilland)
Mosquito TR.Mk 33 (see de Havilland)
'Moujik' (see Sukhoi Su-7U)
Mustang, P-51 (F-51) (see North American)
Myasishchev M-4/3M 'Bison': **80**
Mystère (see Dassault)
Mystère IVA (see Dassault)

N

NATO (North Atlantic Treaty Organisation): **61**, 66, 74, 80, 93, 120, 141
  2nd Allied Tactical Air Force: 42
Naval Aircraft Factory PN-12: 114
Netherlands
  Royal Netherlands Navy: 117
Noratlas, 2501 (see Nord)
Nord 2501 Noratlas: 150-152, **151**, 154, 156, **156**, **157**
Norseman (see Canadian Car & Foundry)
North American
  F-86 Sabre: 30, 43, 56, 144
  F-100 Super Sabre: 39, 40
  P-51 (F-51) Mustang: 19, 21, 23, 25, 28, 53
  P-51D (F-51D): 142-148, **142**, **144**, 150-153, 155, 156, **156**, **157**
  T-6 Texan/Harvard: 144, 145, 148, 151-156, **154**, **155**
  T-39 Sabreliner: 132
  XB-70 Valkyrie: 134, 135
  XP-86: 30
Northrop
  B-2A Spirit: 113, **113**
  B-35: 29
  F-5A/B/C/D Freedom Fighter: 58
  XP-56: 30
Norton Sound, USS: 116

O

Operation
  Bagration: 22
  Barbarossa: 5-8, 22
  Corporate: 81
  Crossroads: 112, 113, 116, 127
  Dhonanyi: 82
  High Jump: 116, 127
  Hydraulic: 79
  Kadeshas: 153
  Magic Carpet: 56-58, 100, 101
  Magic Palm: 100
  Steiner: 156
  Zitadelle: 16, 17
Ouragan (see Dassault)

P

P.1A (see English Electric)
P.1B (see English Electric)
P2V-5 (see Lockheed Martin)
P3M (see Martin)
P4M Mercator (Model 219) (see Martin)
P4M-1 (see Martin)
P-5A (see Martin P5M-1)
P-5B (see Martin P5M-2)
P5M Marlin (see Martin)
P5M-1 *et seq* (see Martin)
P6M Seamaster (see Martin)
P6Y-1 (see Consolidated)
P7M-1 (see Martin)
P.8 (see English Electric)
P.11 (see English Electric)
P.11 (see PZL)
P.15 *et seq* (see English Electric)
P-38 Lightning (see Lockheed Martin)
P-51 (F-51) Mustang (see North American)
P-80 (F-80) Shooting Star (see Lockheed Martin)
P-85 (see McDonnell)
P-88 (see Mcdonnell F-88)
P.1154 (see Hawker)
Pacer (see Piper)
Packet, C-82 (see Fairchild)
Pakistan
  Air Force: 101
Panavia
  Tornado ADV: 45, 60, 66, 74, 82, 84-86, **85**, **88**, 89, 93, 99, 100
  Tornado IDS: 100
PB2Y Coronado (see Consolidated)
PB4Y (see Consolidated)
PBB/XPPB-1 Sea Ranger (see Boeing)
PBM Mariner (see Martin)
PBM-1 *et seq* (see Martin)
PBY Catalina (see Consolidated)
PBY-4 (see Consolidated)
Phantom, FH (see McDonnell)
Phantom II, F-4 (see McDonnell Douglas)
Phantom II, F4H (see McDonnell)
Piper
  L-4 Grasshopper/Cub: 144, 149, 151, 155, 156
  Pacer: 156
  Super Cub: 149, **149**, 151, 156, **156**, **157**
PM (see Martin)
PN-12 (see Naval Aircraft Factory)
Po-2 *et seq* (see Polikarpov)
Polikarpov Po-2: 13, 14, 19
PS-1 (see Shin Maywa)
PZL
  P.11: 16
  W-3 Sokol: **154**

R

Republic
  F-84F Thunderstreak: 151, 157
  RF-84F: 35
RF-84F (see Republic)
Rockwell B-1: 141

S

S-3 Viking (see Lockheed Martin)
S.11 Instructor (see Fokker)
S-40 (see Sikorsky)
S-42 *et seq* (see Sukhoi)
S-55 (see Sikorsky)
S-58 (see Sikorsky)
S-199 (see Avia)
SA-16 Albatross (see Grumman)
Saab J 35 Draken: 82
Sabre (see Canadair)
Sabre, F-86 (see North American)
Sabreliner, T-39 (see North American)
Salisbury, USS: 121
Saudi Arabia
  Royal Saudi Air Force: 44, 50, 56, 100, 101
Saunders-Roe SR.177: 42
S.B.5 (see Short)
Seagull, SOC (see Curtiss)
Seamaster, P6M (see Martin)
Sea Ranger, PBB/XPPB-1 (see Boeing)
Sea Venom, D.H.112 (see de Havilland)
Sea Vixen, D.H.110 (see de Havilland)
Sea Vixen FAW.Mk 2 (see de Havilland)
SEPECAT Jaguar: 62, 65, 92, 97
Shackleton, 696 (see Avro)
Shin Maywa PS-1: 121
Shooting Star, P-80 (F-80) (see Lockheed Martin)
Short
  S.B.5: 39, **39**, 40, 76, 90
  Stirling: 145
  Sunderland: 116-118, 120, 124
Sikorsky
  S-40: **123**
  S-55: 149-151, **150**, 153, 154, 156, **156**
  S-58: 150, **150**, 151, 154, 156, 157
Skyhawk, A-4 (A4D) (see Douglas)
Skymaster, C-54 (see Douglas)
Skytrain/Dakota, C-47 (see Douglas)
SOC Seagull (see Curtiss)
Sokol, W-3 (see PZL)
Sopwith Dolphin: 69
Soviet Union
  Air Force (V-VS): 135, 136, 141
  Central Aero & Hydrodynamics Institute (TsAGI): 136, 137
  Central Institute of Aero Engines (TsIAM): 137
  Flight Research Institute (LII): 138, 140
  Red Army: 17, 22, 23, 25
SP-5A (see Martin P5M-1S)
SP-5B (see Martin P5M-2S)
Sparrowhawk, F9C-2 (see Curtiss)
Spirit, B-2A (see Northrop)
Spitfire (see Supermarine)
Spitfire Mk I *et seq* (see Supermarine)
Spitfire PR.Mk 1A *et seq* (see Supermarine)
SR.177 (see Saunders-Roe)
Stampe SV-5: **12**
Starfighter, F-104 (see Lockheed Martin)
Stirling (see Short)
Storch, Fi 156 (see Fieseler)
Stratofortress, B-52 (see Boeing)
Stratofreighter, C-97 (see Boeing)
Stratojet, B-47 (see Boeing)
Stratotanker, KC-135 (see Boeing)
Strikemaster (see BAC)
Su-7 *et seq* (see Sukhoi)
Sud-Aviation
  Alouette II: 150, **150**, 151, 154, 156
  Tritone: 144
  Vautour IIA: 148, **148**, 154, 156
  Vautour IIB: 148, **148**, 149, 154, 155
  Vautour IIN: 142, **143**, 146, **147**, 154, 156
Sukhoi
  S-42: 135
  S-80: 135
  S-84: 135
  Su-7 Mk II 'Fitter-A': 135
  Su-7U 'Moujik': **136**, 138
  Su-9 'Fishpot': **136**, 137
  Su-15 'Flagon': 135
  Su-17: 88
  Su-24 'Fencer': 135
  Su-25 'Frogfoot': 135
  Su-26: 135
  Su-27 'Flanker': 135
  T-4: 134-141, **134-141**
  T6-1: 135
  T6-21: 135
  T8: 135
  T10: 135
Sukhoi T-4: Russia's Mach 3 bomber: 134-141, **134-141**
Sunderland (see Short)
Super Cub (see Piper)
Superfortress, B-29 (see Boeing)
Supermarine
  Attacker: 38, 144
  Spitfire: 25
  Spitfire Mk IX: 142-146, **142**, **144**, 148-151, 153, 155, **155**
  Spitfire PR.Mk 19: 53, **53**
  Swift: 39, 41
Super Mystère (see Dassault)
Super Sabre, F-100 (see North American)
SV-5 (see Stampe)
Swift (see Supermarine)

T

T-4 *et seq* (see Sukhoi)
T-6 Texan/Harvard (see North American)
T-35 (see Temco)
T-35 (see Vultee)
T-39 Sabreliner (see North American)
Tangier, USS: 116
Temco T-35: 148
Texan/Harvard, T-6 (see North American)
The built-in fighter: 26-35, **26-35**
Thunderstreak, F-84F (see Republic)
Tornado ADV/ECR/IDS (see Panavia)
TP-5A (see Martin P5M-1T)
Triplane (see Fokker)
Tritone (see Sud-Aviation)
TSR.2 (see BAC)
Tu-2 *et seq* (see Tupolev)
Tupolev
  Tu-16 'Badger': 80, 81, 86
  Tu-16LL 'Badger': 138
  Tu-22 'Blinder': 138, 141
  Tu-22M 'Backfire': 141
  Tu-91: 134
  Tu-95 'Bear': 80, 81, 86
  Tu-95RT 'Bear-D': **79**
  Tu-104B 'Camel': 138
  Tu-125: 134
  Tu-134 Balkany: 134
  Tu-134A: 134
  Tu-134AK: 134
  Tu-135: 134
  Tu-144: 140
  Tu-160 'Blackjack': 141

U

U-2 (see Lockheed Martin)
U-158: 115
UF-1G Albatross (see Grumman)
United Kingdom
  Air Ministry: 40
  British Army: 142
  Royal Aircraft Establishment (RAE) Farnborough: 39-41
  Aeroplane & Armament Experimental Establishment (A&AEE): 43, 57, 91, 92, 99
  Empire Test Pilot's School: 52, 83, 84, 99
  Royal Air Force: 6, 37, 38, 40, 42-44, 46-48, 51-61, 63-67, 72-74, 79, 81-90, 92-100, 116, 117, 124, 142, 143, 147-149, 151
  Central Fighter Establishment (CFE): 92, 93
  Central Flying School (CFS): 152
  Commands
  Coastal: 116, 117, 124
  Fighter: 37, 43, 45, 50, 51, 54, 64, 65, 92, 94-96, 98
  Strike: 64, 92
  Far East Air Force: 59, 65, 92
  RAF Germany: 48, 50, 58, 62-66, 68, 74, 80, 87, 92-94, 96, 98
  RAF Museum: 91
Royal Navy: 64, 88
  Fleet Air Arm: 38, 46, 64, 96
United Nations: 107, 108, 157
United States
  Air Force: 26-28, 30, 35, 53, 54, 65, 67, 94, 113, 131, 132
  Air Force Museum: 35
  Strategic Air Command: 26, 35, 113
  Army Air Force: 19, 21-23, 27, 29, 30, 102-113, 152
  15th Air Force: 22
  20th Air Force: 110
  XXI Bomber Command: 102, 106
Coast Guard: 114-117, 120, 125-128, 131, 132
Marine Corps: 104, 105, 118
National Advisory Committee for Aeronautics (NACA): 27, 30
Navy: 26, 27, 29-31, 105, 112, 114-133, 153
  Naval
  Air Development Center: 120, 130
  Air Material Command: 123
  Air Reserve: 117
  Air Test Center: 130
  Air Transport Service: 115, 123, 124, 128
Unit Heritage:
  The Atomic Bombers. The 509th Bomb Group in World War II: 102-111, **102-111**
Uruguay
  Navy: 117, 118, 127
UT-2 (see Yakovlev)

V

Valiant BK.Mk 1 (see Vickers)
Valiant tanker (see Vickers)
Valkyrie, XB-70 (see North American)
Vampire, D.H.100 (see de Havilland)
Vautour IIA *et seq* (see Sud-Aviation)
VC10 tanker (see Vickers)
Venom (see de Havilland)
Vickers
  Valiant BK.Mk 1: 45, **45**, **47**, 50, 53, 54, 56, 83
  Valiant tanker: 83, 94
  VC10 tanker: 83
Victor B(K).Mk 1A (see Handley Page)
Victor K.Mk 1 (see Handley Page)
Viking, S-3 (see Lockheed Martin)
Voodoo, F-101 (see McDonnell)
Vulcan K.Mk 2 (see Avro)
Vultee
  BT-13: 144
  T-35: 151, 153

W

W-3 Sokol (see PZL)
W 34 (see Junkers)
Wildcat, F4F (see Grumman)
Windham Bay, USS: 118

X

X-1 (see Bell)
XB-70 Valkyrie (see North American)
XF-85 Goblin (see McDonnell)
XF-88 (see McDonnell)
XFD-1 (see McDonnell)
XP-56 (see Northrop)
XP-67 (see McDonnell)
XP-71 (see Curtiss)
XP-85 (see McDonnell)
XP-86 (see North American)
XP5M-1 (see Martin)
XP5Y-1 (see Consolidated)
XPBM-1 (see Martin)
XPBM-1A *et seq* (see Martin)
XPB2M-1 (see Martin)
XPB2M-1R (see Martin)

Y

Yak-3 *et seq* (see Yakovlev)
Yakovlev
  UT-2: 19
  Yak-9: 22
  Yak-33: 134

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Redfern, via Simon Watson, Paul Jackson. **100:** Ian Black, British Aerospace, Falcon Aviation, BAC via Michael Stroud. **101:** Falcon Aviation (two), BAC, Peter Steinemann, BAC via Michael Stroud. **102:** Carl Garner via Warren Thompson, US Air Force, Robert Kraus via Warren Thompson (two). **103:** Ron Kraus via Warren Thompson (two), John Dulin via Warren Thompson, Carl Garner via Warren Thompson. **104:** Carl Garner via Warren Thompson (two), Ron Kraus via Warren Thompson, John Dulin via Warren Thompson. **105:** Carl Garner via Warren Thompson, Ron Kraus via Warren Thompson. **106:** Carl Garner via Warren Thompson (two), John Dulin via Warren Thompson. **107:** Ron Kraus via Warren Thompson, Kenn Rust Collection via Warren Thompson, Carl Garner via Warren Thompson. **108:** Carl Garner via Warren Thompson (four), US Air Force. **109:** MacClancy Collection (two), US Air Force, Ron Kraus via Warren Thompson. **110:** Carl Garner via Warren Thompson (three). **111:** Ron Kraus via Warren Thompson (two), Carl Garner via Warren Thompson (two), Charles Sweeny via Warren Thompson. **112:** Imperial War Museum, David Wilson via Warren Thompson, R. Frank Schirmer via Robert F. Dorr, Aerospace. **113:** Warren Thompson (seven), Bud Biteman via Warren Thompson, US Air Force, Aerospace, Dylan Eklund Collection (two), Gary Bihary. **114:** US Navy via Robert L. Lawson, NASM Rudy Arnold Collection via Stan Piet/Glenn L. Martin Aviation Museum. **115:** US Navy via Robert L. Lawson, US Coast Gurad, US Navy, Stan Piet/Glenn L. Martin Aviation Museum (two). **116:** US Navy via Robert L. Lawson, via Robert F. Dorr, National Archives, Aerospace. **117:** Gary Kuhn Collection via Robert F. Dorr, MAP, Aerospace, Roger Besecker via Robert F. Dorr, via Stewart Wilson, via Stan Piet/Glenn L. Martin Aviation Museum. **118:** Martin, via Stan Piet/Glenn L. Martin Aviation Museum (two). **119:** US Navy via Peter B. Mersky (two), via Stan Piet/Glenn L. Martin Aviation Museum, Martin. **120:** Peter B. Mersky (three), Martin. **121:** via Stan Piet/Glenn L. Martin Aviation Museum, US Navy (two). **122:** via Robert F. Dorr, Martin, US Navy via Robert F. Dorr, NASM Rudy Arnold Collection via Stan Piet/Glenn L. Martin Aviation Museum. **123:** NASM Rudy Arnold Collection via Robert L. Lawson, US Navy via Robert L. Lawson (four), via Robert F. Dorr. **124:** US Navy via Robert L. Lawson, US Navy, MAP, via Michael Stroud, via Robert F. Dorr. **125:** US Coast Guard, US Navy (two), Martin, US Navy via Robert L. Lawson, via Stan Piet/Glenn L. Martin Aviation Museum. **126:** US Navy via Robert F. Dorr, Martin via Robert F. Dorr, via Stan Piet/Glenn L. Martin Aviation Museum, via Robert F. Dorr, Martin, Larry Davis. **127:** Martin (two), Larry Davis, via Robert F. Dorr (two), US Navy via Robert F. Dorr, Aerospace, US Coast Guard. **128:** US Coast Guard via Robert F. Dorr, via Stan Piet/Glenn L. Martin Aviation Museum (two), Martin (two). **129:** US Navy, Martin (three), Martin via Robert F. Dorr, Jim Winchester Collection. **130:** Martin (three), via Stan Piet/Glenn L. Martin Aviation Museum. **131:** Aerospace, US Coast Guard (two), via Stan Piet/Glenn L. Martin Aviation Museum (two), ECPA. **132:** via Stan Piet/Glenn L. Martin Aviation Museum, US Coast Guard, Boeing, US Navy (two). **133:** via Stan Piet/Glenn L. Martin Aviation Museum (two), Martin (two). **134-135:** Sukhoi Design Bureau via Yefim Gordon. **136:** Yefim Gordon Archive (three). **137-139:** Sukhoi Design Bureau via Yefim Gordon. **140:** Sukhoi Design Bureau via Yefim Gordon (two), Yefim Gordon. **141:** Yefim Gordon (two). **142:** Dan Barak via Shlomo Aloni (SA), Aryeh Fredlis via SA. **143:** Dassault, via Salvador Mafé Huertas, via SA, Achiya Hashiloni via SA, Ran Ronen via SA. **144:** Israel Ben Schachar Collection via SA, Ran Ronen via SA, Yavneh Collection via SA, Dan Barak via SA. **145:** Chaim Niv Collection via SA (three), via Salvador Mafé Huertas (two). **146:** Ran Ronen via SA, via Salvador Mafé Huertas, Ze'ev Tavor via SA, Ezra Aharon Collection via SA, Chaim Niv Collection via SA. **147:** Oded Erez Collection via SA, Israeli GPO via SA, via Salvador Mafé Huertas, IDF Archive via SA, Ze'ev Tavor via SA, via SA. **148:** Aerospace (three), Elyashiv Brogh via SA, Ezra Aharon Collection via SA. **149:** Israel Ben-Schachar Collection via SA, via SA, Aerospace (two), IAF Magazine Collection via SA. **150:** Chaim Niv Collection via SA, Israeli GPO via SA, Uri Yarom via SA (three). **151:** Uri Yarom via SA, Israel Ben-Schachar Collection via SA, Aerospace. **152:** Chaim Niv Collection via SA, Aerospace (two), Israel Ben-Schachar Collection via SA. **153:** Uri Yarom via SA (two), Israel Ben-Schachar Collection via SA. **154:** Dan Barak via SA, Elded Paz Collection via SA, Aerospace, Israel Ben-Schachar Collection via SA. **155:** Chaim Niv Collection via SA (two), Aerospace, Yavneh Collection via SA. **156:** Uri Yarom via SA (two), Israeli GPO via SA, Dan Barak via SA. **157:** Israel Ben Schachar Collection via SA (two), Chaim Niv Collection via SA (three), IAF Magazine via SA, via Salvador Mafé Huertas (two).

CONTENTS

Eastern Front Schlachtflieger

McDonnell XF-85 Goblin

English Electric Lightning

509th Bomb Group

Mariner, Mars and Marlin
Variant Briefing

Sukhoi T-4

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